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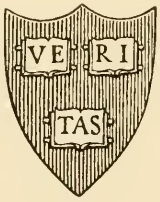

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EXCHANGE

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VII, No. 1, pp. 1-16, plate 1, map

A NEW SPECIES OF XANTUSIA FROM ARIZONA, WITH A SYNOPSIS OF THE GENUS

BY

LAURENCE M. KLAUBER

Curator of Reptiles and Amphibians, San Diego Society of Natural History

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SAN DIEGO, CALIFORNIA

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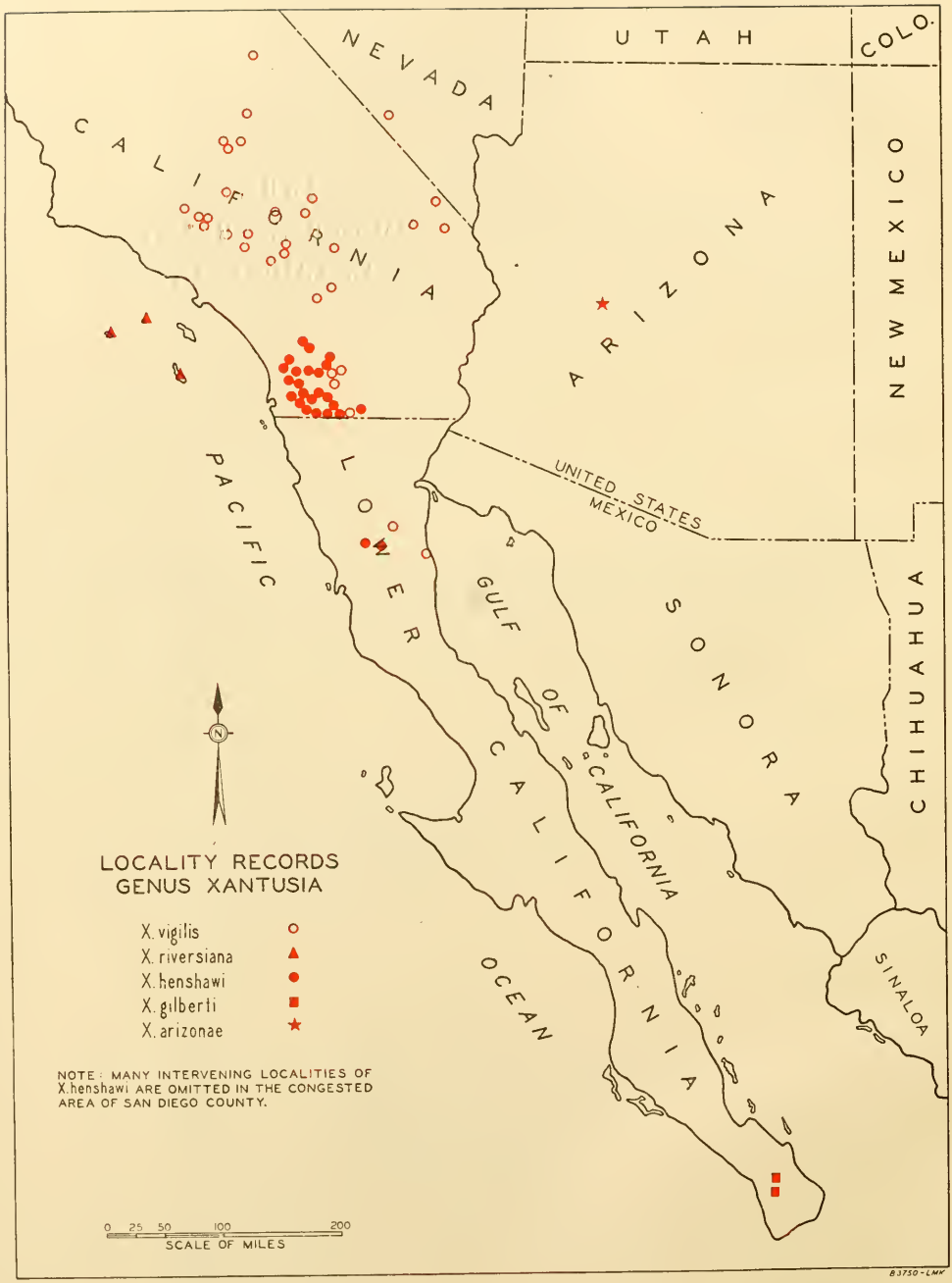
OCTOBER 6, 1931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SONORA
CHIHUAHUA
SINALOA
OCEAN
LOCALITY RECORDS
GENUS XANTUSIA
X. vigilis
X. riversiana
X. henshawi
X. gilberti
X. arizonae
NOTE: MANY INTERVENING LOCALITIES OF X. henshawi ARE OMITTED IN THE CONGESTED AREA OF SAN DIEGO COUNTY.
0 25 50 100 200
SCALE OF MILES
B3750-LMK

A NEW SPECIES OF XANTUSIA FROM ARIZONA, WITH A SYNOPSIS OF THE GENUS

BY

LAURENCE M. KLAUBER

Curator of Reptiles and Amphibians, San Diego Society of Natural History

On August 21st, 1931, my son Philip and I were driving toward Phoenix, Arizona, from Prescott on the return trip from the Hopi Snake Dance at Mishongnovi. On the up-grade south of Yarnell, we were both struck with the similarity of the granite-boulder and chaparral covered hillside to our own San Diego County foothills. Noting several likely looking flakes on the rocks, we decided to look for night lizards of the genus *Xantusia,* using the technique and prying bars especially developed in the pursuit of *X. henshawi* in Southern California. We had hardly reached the third or fourth flake when our anticipations were rewarded, for there was a *Xantusia,* quite evidently different from any with which we were familiar. Here was a thrill such as the collector always anticipates, but (in this settled country, at least) all too seldom achieves.

The novelty of this form, the first *Xantusia* to be reported from Arizona, has now been verified by detailed comparisons with the four known species of the genus, and I therefore describe it as

Xantusia arizonae, sp. nov.

ARIZONA NIGHT LIZARD

Plate 1, figs. 1, 2.

Type.—No. 5433, adult female, in the collection of LMK. Collected one mile south of Yarnell, Yavapai County, Arizona, elevation 4940 ft., Aug. 21, 1931, by P. M. and L. M. Klauber. Paratypes, 5, Nos. 5434-8, collected at the same time and place. Also 5451-2 born (dead) of the type in captivity, and 5450 and 5453, unborn embryos removed from 5436 and 5434 respectively. Total specimens, including embryos, 10.

Diagnosis.—A species of *Xantusia* resembling *vigilis* in lepidosis and, partly, in color and pattern, but differing from that species in bodily form, in which characteristic it tends toward *henshawi,* having relatively longer limbs and more depressed head and body than *vigilis.*

Description of the Type.—The limbs are moderately short, with head and body depressed. The tail is subconical. The upper surface of the head is flat,

somewhat concave between the eyes, and curving downward to the snout. There are three gular and a pair of dorsolateral folds. The ear opening is large and prominent. The eye is large and with a vertical pupil. There are no eyelids. The nostril is at the lower edge of the suture between the internasal and postnasal. The rostral is broad, low and rounded, and is followed by median dorsal head scales in the following order: A pair of small internasals, a large hexagonal frontonasal, a pair of prefrontals, a large hexagonal frontal, a pair of frontoparietals, a large hexagonal interparietal (narrower anteriorly), a pair of subquadrate occipitals and, finally, two small triangular interoccipitals. All five of the paired groups are in contact on the median line. A pair of parietals completes the series of principal head plates. On the sides each frontonasal contacts a postnasal and preloreal; the prefrontals touch the loreals and first superciliary, while the frontal is bordered by the second superciliary on each side. The frontoparietals outwardly contact the four posterior superciliaries. A row of somewhat enlarged supratemporals engages the outer edges of the parietals and occipitals. The interparietal and the two occipitals are approximately equal in area; the frontal, frontoparietals and parietals comprise a second group of subequal areas.

On the sides of the head, following the postnasals, there is a pair of loreals (the anterior smaller), and then two small preoculars. Behind the eye the postoculars are not enlarged. The ear opening is weakly denticulated anteriorly.

There are eight enlarged supralabials on the right and seven on the left. The first four are larger and subequal; the fourth to sixth engage the orbit.

Below, there are six infralabials on each side. The mental is triangular, with an extra infralabial split off on the left. There are three enlarged sublabials (postmentals) on each side, the first pair in contact, the second separated by a single small scale, and the third by five scale rows. The scales between the sublabials decrease in size posteriorly until a minimum is reached at the first gular fold, which joins the ear openings. The other two folds are at the neck; there are five enlarged central scales on the posterior fold.

The back, sides and upper limb surfaces are covered with small circular scales arranged in rather even rows, there being an average of 46 such scales per row transversely at mid-body. The undersurface is covered with enlarged square scales, except that the outer rows are semicircular. There are 33 such rows longitudinally (including the enlarged preanals) and twelve counting transversely. The anterior surfaces of the limbs likewise have enlarged scales.

The tail is subconical and is sheathed with rings of quadrate scales, there being approximately 68 such rings. The tail may be original and complete but this is not certain. Femoral pores seem absent in the type; they number 9 to 12 in three paratypes.

The measurements of the type are as follows (all figures indicate millimeters): Length over all 119; length of body (rostral to anus) 54; length of tail 65. Shielded part of head 11; rostral to first gular fold 11, to second gular fold 15, to third gular fold 18; width of head 8.4, depth of head 4.7. Rostral to

anterior edge of ear 10.5. Diameter of eye 1.9. Length of fore limb 16.5, of hind limb 24; from base to fifth to tip of fourth toe 9. Forelimb spread 40, hind limb spread 56.[1]

The head above is drab with a conspicuous dark diamond centering on the interparietal. The outer edges of the central head plates are definitely lighter. There are a few irregular dark spots on the nose. There is a conspicuous dark streak on each side of the head, from the nasal aperture across the orbit, and engaging the second row of blotches on either side of the mid-dorsal row. Below these lines, on the sides of the head, are other black dots, some of which engage the lower labials and chin shields.

The ground color of the body in life is citrine-drab (Ridgway, 1912, pl. 40) irregularly mottled with sub-elliptical black spots which are somewhat larger and denser on the sides than on the back. These spots average about 2.0 by 0.8 mm. To a slight extent the dorsal blotches have a regularity suggesting longitudinal rows, of which there are seven between dorsolateral folds.

The tail and legs are similarly spotted; the ground color of the tail is somewhat lighter and the spots less numerous toward the tip. The ventral surface is immaculate, except on the edges, and somewhat transparent.

Upon preservation in alcohol the colors become lighter, but not conspicuously so.

The iris is golden, the pupil black and vertical.

Variations in Paratypes.—The following conclusions are drawn from the type and five adult paratypes, the juveniles being too imperfect to permit accurate scale counts.

The longitudinal scale rows number twelve in all cases. The transverse rows vary from 32 to 34 (including the preanals), averaging 32.8. The average of the rows of small scales across the back at mid-body varies from 45 to 47, the grand average being 46.3. The tail rows vary from 68 to 88, but it is difficult to tell whether the tails are complete and original. The supralabials vary from seven to nine, being usually eight; the infralabials are normally seven, less often six. The superciliaries vary from four to eight. The scales between the sublabials are 1+4 or 1+5. The preoculars are two or three. There are no important abnormalities in the plates on the top of the head in any of the adult paratypes. The small interoccipitals are entire in one specimen. The enlarged scales on the postgular fold vary from four to eight. The femoral pores (evident in the males only?) vary from nine to twelve, averaging 10.7. The number of rings on the fourth toe averages 25.

The adults are quite uniform in size, form and markings. Regenerated tails are somewhat lighter. The most perfect juvenile (born dead) measures 62 mm. over all, with a body length of 27 mm. The spotting of the adults is less evident in this juvenile.

---

[1] These two measurements taken while the specimen was pliable.

Habits and Habitat.—The country where these lizards were found is a rocky hillside with large granite boulders interspersed with heavy chaparral (Plate 1, figure 3). Some cactus is also present. In many characteristics the terrain closely resembles the San Diegan Upper Sonoran at about 3500 ft. altitude.

The granite boulders flake as they do in San Diego County. However, the specimens of *Xantusia* were found under slabs, rather than thin flakes, and on the shady sides of the boulders. Reasoning from the analogous habits of *Xantusia henshawi* (see Copeia No. 152, p. 115) it is probable that in the spring and autumn, when the sun's warmth would be more appreciated than in the oppressive summer, the lizards should be found under the thin outer flakes, rather than in the deeper cracks, and would thus be much easier to discover.

Obviously not much may be said concerning habits on such short acquaintance. The method of capture is the same as with *henshawi;* the slabs and flakes are pried off the parent boulder and the lizards are caught with the fingers while still light-struck. At the time of collection the temperature was about 85 degrees F., in consequence of which the rocks were quite warm, and, as above suggested, most of the lizards had no doubt taken refuge in the deeper crevices. Altogether we hunted for about three hours, securing six adult specimens and losing one.

Arizonae is somewhat easier to catch than *henshawi,* for it does not move so quickly when uncovered. As is the case with the latter, it clings to the parent boulder and not to the slab pried off. It bites if not caught by the head. It curls around the finger as does *henshawi* and, in addition, twists laterally, a motion which the California form does not have. When uncovered, *arizonae* does not change color conspicuously as does *henshawi,* but seems to become slightly lighter in ground color.

The reptilian associates of the new lizard, which we collected in the same locality, are *Masticophis taeniatus taeniatus* (the only snake taken here), *Crotaphytus collaris,· Uta ornata symmetrica, Sceloporus consobrinus, Cnemidorphorus sexlineatus perplexus,* and *Holbrookia texana.* The *Uta* and *Sceloporus* were quite common among the rocks and were found under slabs and flakes while in search of *Xantusia;* they were in fact more frequently discovered than the night lizards. Three of the *Xantusia* were successfully transported alive across the desert to San Diego, by keeping them in a jar wrapped in cloths continually moistened.

From the specimens taken it is evident that this species is ovovivi-

parous, giving birth to one or two young alive about September 1st.

The food, as shown by two stomachs examined, included the following: Weevils (*Curculionidae*), beetles (*Coccinelidae*), ants (*Formicidae*) and bugs (*Hemiptera*). (Identifications by W. S. Wright).

Discussion.—Xantusia arizonae is the first of the genus to be recorded from east of the Colorado River. Hitherto the known range has been restricted to the Californias, including some of the coastal islands, and the southern tip of Nevada, where *vigilis* was collected by the Death Valley Expedition.

The new species is undoubtedly more closely related to *vigilis* than to the other species. This is to be expected from geographical considerations and is indicated by similarity of scutellation and a certain resemblance in the markings.

Some specimens of *vigilis* are decidedly reminiscent of the bolder pattern of *arizonae,* and there is a likeness in the head marks. But the difference in habitat has definitely differentiated the yucca-branch, desert inhabiting *vigilis,* (although this habitat is not universal with the species) from the rock inhabiting, Upper Sonoran *arizonae,* so that the latter has come to resemble *henshawi,* of similar life habit, although without so extreme a morphological modification. Thus we find *arizonae* with flatter head and body than *vigilis,* of larger size and with proportionately longer limbs and toes.

A few of the differences between *arizonae* and *vigilis* which may be presented statistically are as follows:

	Arizonae	*Vigilis*
Scale rows across dorsum[2]	45—47	35—39
Ratio of head width to depth	1.48-1.78	1.32-1.39
Ratio of length of plated head section to length of fourth toe	1.26-1.32	1.57-1.79
Ventral scale row reached by adpressed fore limb	16—20	13—14
Ventral scale row reached by adpressed hind limb	5—9	12—17
Lamellae on fourth toe	25—26	18—20

Further differences of like character might be listed, but these will suffice to indicate the definite separation of the two species in bodily form.

---

[2] These figures represent an average of several counts on each specimen taken approximately at mid-body. Some of these rows begin at the tips of the ventrals, others at the interstices, so that a variation of 3 to 5 is to be expected in the several counts on each specimen. The extremes of all mid-dorsal counts in *arizonae* were 43 to 50, and in *vigilis* (16 specimens) 33 to 40.

A SYNOPSIS OF THE GENUS XANTUSIA

Xantusia Baird, Proc. Acad. Nat. Sci. Phila., 1858, p. 255.
Zablepsis Cope, Am. Nat., 1895, Vol. 29, p. 758.
Amoebopsis Cope, Am. Nat., 1895, Vol. 29, p. 758.

1. *Xantusia vigilis* Baird, Proc. Acad. Nat. Sci. Phila., 1858, p. 255. (Type locality, Fort Tejon, Kern Co., Calif. Type specimen, USNM 3063).

Common Name: Desert Night Lizard.

Complete Description and Photograph: Van Denburgh, 1922, Reptiles of Western North America (Occ. Papers. Cal. Acad. Sci., 10), p. 477.

Habits: Van Denburgh, 1895, Proc. Cal. Acad. Sci., Ser. 2, Vol. 5, pp. 526-529; Bogert, 1930, Bull. Sou. Cal. Acad. Sci., Vol. 29, Part 1, p. 8.

Sherwin F. Wood writes me as follows: "Feb. 22, 1931, on a clear, bright sunny day, with a cold, strong wind, ten *X. vigilis* were collected in one hour at noon on the Mohave Desert two miles west of Palmdale, Los Angeles County. All were found under dead bushes, in the moist debris under roots or under the bark, sometimes even in holes made by termites. They were easy to capture because of the coolness prevalent in their surroundings. Only one was found in the dead trunk of a Joshua Tree; the rest were obtained from dead 'clump bush' a common shrub of the desert."

Other collectors have told me of finding this species amongst dead leaves and debris, and even in excavations. However, the most prolific source of specimens remains that originally discovered by Van Denburgh, that is, under and in the fallen, dead branches of the Joshua Tree (*Yucca brevifolia*). But this lizard must not be considered dependent on the tree-yucca; it is found in areas where this plant does not exist.

Range: The deserts and desert mountains of the Californias and southern Nevada from the Inyo Mountains, Inyo County, California to San Felipe Bay and San Matias Pass, Lower California, Mexico.

Localities of Collection:

Inyo County
East Slope, Inyo Mts.
8 mi. N. W. of Little Lake

Kern County
- Fort Tejon (Type Locality)
- Mojave
- Kelso Creek Valley (4½ and 7 mi. S. E. of Weldon)
- Freeman Canyon (Walker Pass)
  (4900 ft., max. recorded altitude for this species)

Los Angeles County
- Antelope Valley
- Pine Creek
- Neenach
- Pallett
- Fairmont
- Peck's Butte
- Palmdale
- Lovejoy Buttes

San Bernardino County
- Hesperia
- Victorville
- Barstow
- Providence Mts.
  (near Bonanza King Mine)
- Lane's Mill
  (Lane's Well)
- Kramer Hills
- Goffs
- Purdy
- 30 mi. S. E. of Daggett
- Morongo Canyon
- Lone Pine Canyon

Riverside County
- Cabazon

San Diego County
- San Felipe Valley
- La Puerta (Mason Valley)
- Yaqui Well
- Jacumba

Clark County, Nevada
- Pahrump Valley

Lower California
- San Matias Pass
- San Felipe Bay

2. *Xantusia riversiana* Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 29.[3] (Type locality, California; later stated to be San Nicolas Island.[4] Type specimen, MVZ 8278).

COMMON NAME: Island Night Lizard.

COMPLETE DESCRIPTION AND PHOTOGRAPH: Van Denburgh, 1922, Reptiles of Western North America, p. 486.

HABITS: Ibid.

RANGE: Islands off the coast of California.

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[3] The name is first mentioned, without description, in Am. Nat., 1879, Vol. 13, p. 801.

[4] RIVERS, Am. Nat., 1889, Vol. 23, p. 1100.

LOCALITIES OF COLLECTION:[5]

San Nicolas Island (Type Locality)
San Clemente Island
Santa Barbara Island

3. *Xantusia henshawi* Stejneger, Proc. U. S. Nat. Mus., 1893, Vol. 16, p. 467. (Type locality, Witch Creek, San Diego Co., Calif. Type specimen, USNM 20,339).

Zablepsis henshavii Cope, Am. Nat., 1895, Vol. 29, p. 758.

Xantusia picta Cope, Am. Nat., 1895, Vol. 29, pp. 859, 939. (Type locality, Tejon Pass?)[6]

COMMON NAME: Spotted Night Lizard.

COMPLETE DESCRIPTION AND PHOTOGRAPH: Van Denburgh, 1922, Reptiles of Western North America, p. 484.

HABITS: Atsatt, Copeia, 1925, No. 146, pp. 71-72; Klauber, Copeia, 1926, No. 152, pp. 115-117.

RANGE: Rocky areas on both slopes of the mountains from southern Riverside County, California, to the San Pedro Mártir Mountains of Lower California.

LOCALITIES OF COLLECTION:

Riverside County
- Aguanga

Imperial County
- Boulder Park
- Mountain Spring
- Myers' Creek Bridge

San Diego County
- Witch Creek (Type Locality)
- Valley Center
- Sylvano
- Crescent Valley
- San Pasqual
- Poway
- Mussey
- Foster
- El Monte
- Lakeside
- Flinn Spring
- Grossmont
- Hillsdale
- Dehesa
- Helix
- Jamacha
- Oak Grove
- Wynola
- Sutherland
- Ballena
- Pamo
- Goose Valley
- Ramona
- Mt. Woodson
- Wildwood
- Shady Dell

5 There is also a doubtful record from Santa Catalina Island.

6 For a discussion of this type locality see Van Denburgh, Copeia, 1916, No. 27, p. 14.

San Diego County—Continued

Viejas	Dulzura	Borego Palm Canyon
Descanso	Cottonwood	Grapevine Spring
Guatay	Tecate	La Puerta (Mason Valley)
Pine Valley	Buckmans	Newtown
Noble Mine	La Posta	Hipass
Glen Lonely	Clover Flat	Boulevard
Alpine	Campo	Jacumba
Harbison Canyon	Laguna Junction (4050 ft., max. recorded altitude for this species in San Diego Co.)	
Suncrest		
Jamul		
Lyons Valley		
Deerhorn Flat		

Lower California

Arroyo Encantada, San Pedro Mártir Mts. (7300 ft., max. recorded altitude for this species)

San José (Lat. 31 deg.)

4. *Xantusia gilberti* Van Denburgh, Proc. Cal. Acad. Sci., 1895, Ser. 2, Vol. 5, p. 121. (Type locality, San Francisquito, Sierra Laguna, Lower California. Type specimen, CAS 401).

Amoebopsis gilbertii Cope, Am. Nat., 1895, Vol. 29, p. 758.

COMMON NAME: San Lucan Night Lizard.

COMPLETE DESCRIPTION: Van Denburgh, 1922, Reptiles of Western North America, p. 482.

RANGE: The Cape region of Lower California.

LOCALITIES OF COLLECTION:

San Francisquito, Sierra Laguna, Lower California
La Laguna, Sierra Laguna, Lower California

VALIDITY: While I still recognize this form in the key which follows, it must be admitted that the distinguishing characters are tenuous. Van Denburgh originally differentiated *gilberti* from *vigilis* based on a divided frontal and the separation of the prefrontals by the frontonasal. Schmidt (Bull. Am. Mus. Nat. Hist., Vol. 46, p. 672) has shown that, of the two known specimens of this species, only the type has a divided frontal, and that this character occasionally appears in California specimens, which is borne out by two such individuals in my collection. The other character likewise does not hold in the second specimen of *gilberti*. Schmidt, however, finds in the second specimen a smaller and flatter head, a more

pointed nose, and smaller eye than in *vigilis;* also a narrower separation of the second pair of postmentals (sublabials). I find all of these characters variable in my series of *vigilis,* especially the last. Color and spotting are likewise highly variable in *vigilis,* for some from the Mohave desert are nearly unicolor, while others are conspicuously maculate. So, for the present, this must be considered a somewhat doubtful species, the verification of which will await the advent of more specimens from the Cape region of Lower California. No doubt specimens of the *vigilis-gilberti* group will eventually be forthcoming from between San Felipe Bay (the present known southern range limit of *vigilis*) and the Cape, for the intervening territory is of a character suited to the genus. With additional material at hand *gilberti,* if valid, may prove a subspecies of *vigilis.*

5. *Xantusia arizonae* (cf. this paper).

COMMON NAME: Arizona Night Lizard.

DESCRIPTION, HABITS, LOCALITY OF COLLECTION: See above.

KEY TO SPECIES OF THE GENUS XANTUSIA

(Adapted from Van Denburgh and Schmidt, and extended to include the new species).

1. Two series of small plates (superciliaries and supraoculars) over the eye; ventrals in 16 longitudinal rows (*i.e.* counted transversely) ..... *riversiana*
   One series of small plates (superciliaries) over the eye; ventrals in 14 or fewer longitudinal rows 2

2. Ventral plates in 14 longitudinal rows ..... *henshawi*
   Ventral plates in 12 longitudinal rows 3

3. Dorsal scales across midbody[7] number 42 or more ..... *arizonae*
   Dorsal scales across midbody number less than 42 4

4. Eye larger ..... *vigilis*
   Eye smaller ..... *gilberti*

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[7] See footnote, p. 7.

EXPLANATION OF PLATE

PLATE I

Fig. 1. Dorsal view of *Xantusia arizonae*, Arizona Night Lizard.

Fig. 2. Side view of *Xantusia arizonae*, Arizona Night Lizard.

Fig. 3. Type locality of *Xantusia arizonae*, Arizona Night Lizard.

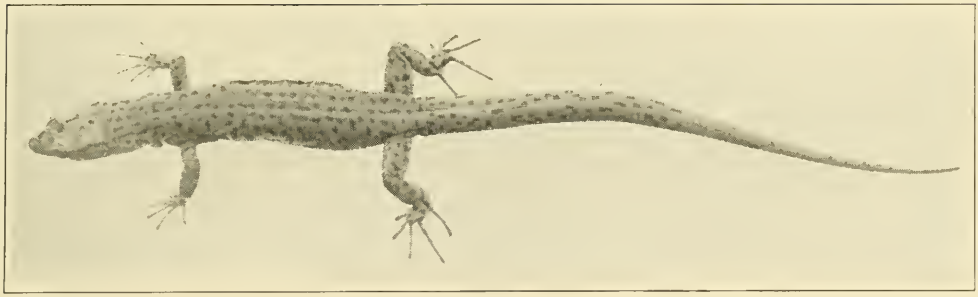

Fig. 1

Fig. 2

Fig. 3

28,898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VII, No. 2, pp. 17-20 October 6, 1931

TWO NEW GROUND SQUIRRELS FROM LOWER CALIFORNIA, MEXICO

BY

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The study of specimens of the larger ground squirrels, *Citellus,* collected in central and northern Lower California by members of the San Diego Society of Natural History's museum staff during the past several years reveals the presence of two heretofore unrecognized races. The writer wishes to acknowledge the loan of comparative material from the California Academy of Sciences through Mr. H. S. Swarth, and from the University of California Museum of Vertebrate Zoology through Dr. Joseph Grinnell. He also wishes to express his thanks to Mr. Arthur H. Howell of the United States Bureau of Biological Survey, who is at present revising this group of mammals, and who generously stated that he had no objection to the naming of new forms from Lower California, while the revision is in preparation.

Citellus beecheyi rupinarum subsp. nov.

Catavina Ground Squirrel

Type.—From Cataviña, Lower California, Mexico, lat. 29° 54′ north, long. 114° 57′ west; no. 8251, collection of the San Diego Society of Natural History; female subadult; collected by Laurence M. Huey, October 9, 1930.

Characters.—Compared with *Citellus beecheyi nudipes*[1] from the mountainous district to the north, *rupinarum* is grayer dorsally. An abundance of light

[1] See the present paper, page 18.

spots on the back, sides and rump gives this form a very hoary appearance. The underparts are pale, almost white, not at all like the very dark *Citellus beecheyi atricapillus* from the central-southern parts of the peninsula or the brownish *nudipes*.

Compared with *atricapillus, rupinarum* is decidedly lighter and grayer. The bright mantles stand out conspicuously, as compared with the very dark, almost obsolete shoulder patches of *atricapillus*.

Cranially, *rupinarum* bears greater similarity to *atricapillus* than to any of the more northern races. The maxillary arches are less flaring in both *rupinarum* and *atricapillus* than are those of either *nudipes* or *beecheyi*. However, the malar is much lighter in *rupinarum* than in *atricapillus*, being not unlike that of *nudipes*. The posterior portion of the brain case is more flattened in *rupinarum* than in either *atricapillus* or *nudipes*.

Measurements.—Type: Total length, 405; tail, 188; hind foot, 55; ear, 17. *Skull (type)*: Greatest length, 52.7; greatest width, 30.9; interorbital constriction, 12.2; nasals, 18.5; tooth row, 11.5.

Range.—The range of this race lies south of the southern parts of the Sierra San Pedro Mártir and north of the Vizcaíno Desert, Lower California, Mexico. So far only specimens from Cataviña have been examined.

Citellus beecheyi nudipes subsp. nov.

Sierra Juarez Ground Squirrel

Type.—From Laguna Hanson, Sierra Juárez, Lower California, Mexico, altitude 5200 feet; lat. 31° 58′ north, long. 115° 53′ west; no. 2015, collection of the San Diego Society of Natural History; female adult; collected by Frank Stephens, October 13, 1926.

Characters.—Compared with *rupinarum*, this form is darker dorsally and lacks the hoary gray appearance of its southern relative. The underparts are also darker and more brownish. The mantle, however, is a clearer, more silvery white.

Compared with *Citellus beecheyi beecheyi*, from the vicinity of San Francisco and Monterey, California (type locality), *nudipes* lacks hair on the entire sole of the hind foot, has a more clearly defined, brighter mantle and grayer cheeks and forehead. The underparts are lighter, lacking most of the dark brownish color found in *beecheyi* from the above-mentioned localities.

Cranially, *nudipes* is similar to *beecheyi*, having a more flaring spread of the maxillary arches than either of the forms *rupinarum* or *atricapillus*, whose ranges are to the southward.

It will thus be seen that *nudipes* is cranially more like *beecheyi* than like *rupinarum*, but in external characters approaches more closely to *rupinarum* than to *beecheyi*.

Measurements.—Type: Total length, 376; tail, 142; hind foot, 55; ear, 18. *Skull (type)*: Greatest length, 54.2; greatest width, 33.0; interorbital constriction, 13.0; nasals, 18.7; tooth row, 11.7.

Range.—The mountainous area of northern Lower California, Mexico, westward to the coast.

Remarks.—Specimens from the coastal regions of southern California, from Point Conception south to the vicinity of the International Boundary, are variously intermediate between *beecheyi* and *nudipes*. In all probability they represent an undescribed race. The relationship of *nudipes* tends coast-wise towards *beecheyi* rather than towards the more northern inland race *Citellus beecheyi fisheri*, although it does have a bright mantle similar to that of *fisheri*.

Recently Howell[2] described a race of ground squirrels (*Citellus beecheyi parvulus*) ranging in the Argus and Panamint Mountains, Inyo County, California, and southward. The present writer, however, after considerable study fails to recognize any constant appreciable difference between specimens taken in the Argus and Panamint Mountains and those from the vicinity of the south fork of the Kern River, in which region lies the type locality of *C. b. fisheri*. There does seem to be some variation in size between specimens of *fisheri* from the San Joaquin Valley and those of the desert ranges. But the necessity of accepting, as typical of the race *fisheri*, the specimens from the Kern River region, which are mediary, both in geographical location and in physical characters, between the two extremes, precludes, in the writer's estimation, separate recognition of the squirrels at either extreme.

Regarding the southern extent of the range of *fisheri*, the writer's conclusion conforms with that of Grinnell and Dixon.[3] A specimen examined from Palm Springs, Riverside County, California, was found to agree in most characters with examples of *fisheri* from the Kern River region.

An interesting fact presented itself in the study of this assemblage of material. It was found that the lightest race (*C. b. rupinarum*) and the darkest race (*C. b. atricapillus*) occupied contiguous territory of approximately the same elevation and distance from the sea. A partial explanation may be found when the physiography of the ranges of the two races is considered. The region occupied by *atricapillus*, the dark form, is almost entirely covered with black lava, while that of *rupinarum* is entirely granitic and gray in color. Thus it would seem that environmental conditions proved to be the determining element in the color development of the two races.

Specimens examined.—*Citellus beecheyi beecheyi*: San Mateo County, California, 9 (6 from Redwood City; 1 from Los Gatos; 2 from Portola); Alameda County, California, 1 (Berkeley); Contra Costa County, California, 1 (La Fayette); Santa Clara County, California, 1 (Mount Hamilton); Monterey County, California, 27 (20 from Monterey; 5 from Seaside; 1 from Bryson; 1 from Partington Point); Los Angeles County, California,[4] 9 (2 from Castaic;

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2 Journal of Mammalogy, Vol. 12, No. 2, p. 160, May, 1931.

3 Natural History of the Ground Squirrels of California, by Joseph Grinnell and Joseph Dixon: Monthly Bulletin of the State Commission of Horticulture, Vol. 7, Nos. 11-12, p. 597-708, Jan. 27, 1919.

4 Specimens from the coastal region south of Point Conception are not typical *C. b. beecheyi*.

5 from Monrovia; 2 from San Pedro); Riverside County, California, 1 (Aguanga); San Diego County, California, 12 (5 from San Diego; 1 from Santa Ysabel; 2 from Witch Creek; 1 from Ballena; 1 from El Monte; 1 from Jamacha; 1[5] from North Cuyamaca Mountains). *Citellus beecheyi fisheri*: Fresno County, California, 3 (Coalinga); Kern County, California, 10 (1 from McKittrick; 1 from Havilah; 2 from Kern River at Isabella; 1 from Kern River, 12 miles below Bodfish; 1 from Kern River, 7 miles above Kernville; 2 from Fay Creek, 6 miles north of Weldon; 1 from 9 miles east of Onyx; 1 from west slope of Walker Pass); Inyo County, California, 7 (6 from Jackass Spring, Panamint Mountains; 1 from 4 miles south of Junction Ranch, Argus Mountains); San Bernardino County, California, 2 (1 from Bear Valley, San Bernardino Mountains; 1 from Hesperia); Riverside County, California, 2 (1 from San Jacinto Mountains; 1 from Palm Springs). *Citellus beecheyi nudipes*: Lower California, Mexico, 14 (1 from south side Descanso Bay; 5 from Laguna Hanson, Sierra Juárez; 1 from Sangre de Cristo; 8 from El Valle de la Trinidad). *Citellus beecheyi rupinarum*: Lower California, Mexico, 4 (Cataviña). *Citellus beecheyi atricapillus*: Lower California, Mexico, 10 (San Ignacio).

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[5] Tending toward *C. b. nudipes*.

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TRANSACTIONS

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NOTES ON THE RACES OF SALTATOR GRANDIS (LICHTENSTEIN)

BY

A. J. VAN ROSSEM

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The *Saltator grandis* of Ridgway's 1901 treatment is now well known to be a composite of several races whose characters were in some degree suggested by that author's measurements and comments but which, because of the small number of specimens then available, could not be named. Berlepsch, in his "Revision der Tanagren" (Verh. des V Inter. Orn. Kong., Berlin, 1911) first recognized the pale race of the Yucatan peninsula and still more recently Griscom, in connection with his studies on the Dwight collection of Guatemala birds, has distinguished (Amer. Mus. Novit., 438, 1930) a dark race from the Pacific coast of Guatemala and Nicaragua and, in addition, has given us valuable comments on the range of the typical form.

Previous to the appearance of Griscom's paper the present writer had done some work with this species, in fact had named in manuscript the Pacific coast race on the basis of a series from El Salvador. Griscom's name of *hesperis* is of course strictly applicable to the Salvador birds and I am happy to be able to vouch for the validity of the form whose characters, as compared to typical *grandis,* are the more plumbeous (less olive) upperparts, decidedly darker and more grayish (less brownish) underparts and shorter superciliary streak. The only three specimens from northwestern Costa Rica in the Dickey collection I had included with the Salvador birds on the basis of their color characters, but only tentatively and with considerable doubt because of their smaller size and different

wing and tail proportions. Through the courtesy of the Los Angeles Museum and its Curator of Birds, Mr. George Willett, I have recently had the opportunity of seeing eight more Costa Rican skins of this species. Since these have proved to be consistently similar to the trio originally examined, there would appear to be every reason to characterize and name the gray saltators from northwestern Costa Rica as a distinct race. This may be known as

Saltator grandis brevicaudus subsp. nov.

Type.—Male adult in relatively fresh, unabraded plumage; no. 22,559, collection of Donald R. Dickey; Aranjuez, Puntarenas, Costa Rica; February 24, 1928; collected by Austin Smith.

Subspecific characters.—Differs from *Saltator grandis grandis* (Lichtenstein) of the Atlantic slope of southern Mexico and Central America and from *Saltator grandis hesperis* Griscom of the Pacific slope of Guatemala, El Salvador and Nicaragua in smaller size and relatively as well as actually much shorter tail. In color *brevicaudus* is very similar to *hesperis* but averages even darker, though with the rump and upper tail coverts slightly more olive and less purely plumbeous. Compared to *grandis* the upperparts are darker and more plumbeous (less olive), the underparts and flanks are darker and more grayish (less brownish) and the white superciliary streak is shorter and reaches scarcely behind the posterior corner of the eye. The wing and tail measurements of the type are, in millimeters, 98.0 and 93.0 respectively.

Range.—Pacific slope of northwestern Costa Rica (Aranjuez, Puntarenas, 2; Tambor, Guanacaste, 7), east to the north-central highlands (Volcan Irazú, 1).

In typical form both *grandis* and *hesperis* have the tail longer than the wing, in which connection the reader may also consult the table of measurements appended (on page 667 of Part 1 of The Birds of North and Middle America) to Ridgway's synopsis of the species. The measurements there given for "Nicaragua" birds I suspect may, in part at least, be better applicable to *brevicaudus* for Nutting, when collecting for the Smithsonian Institution, took three specimens at Sucuyá (see Proc. U. S. Nat. Mus., 6, 1883, 382) in the extreme southwestern corner of that country and only a short distance north of the Costa Rica-Nicaragua boundary.

Griscom did not have available any specimens from the range of *brevicaudus* but two from "eastern Costa Rica" he considered to be best referable to *grandis*. The single specimen from the Atlantic slope of Costa Rica available to me is from Cartago near the summit of the Continental Divide, though on the Atlantic drainage. In characters it is so nearly intermediate between *grandis* and *brevicaudus* that its allocation is a matter of difficulty, though in the absence of a series from that locality I have referred it to the former. The Volcan Irazú specimen, which is certainly *brevicaudus,* was taken at 5000 feet altitude at San Isidro on the Pacific drainage.

The relative lengths of the wing and tail measurements of *hesperis* and *brevicaudus* may be seen from the following table.

	WING	TAIL
S. g. hesperis		
9 ad. males from Salvador	101.0 - 107.5	101.5 - 111.0
5 ad. females from Salvador	100.0 - 107.5	100.0 - 108.5
S. g. brevicaudus		
5 ad. males from Costa Rica	97.5 - 100.0	90.0 - 93.0
5 ad. females from Costa Rica . . .	94.0 - 99.0	88.0 - 92.0

In the process of "running down" old names, which although hitherto considered to be synonyms of *grandis* in the old collective sense might possibly have been utilized for one of the newer divisions, it has been necessary to consider the *Saltator rufiventris* of Vigors which was first described in 1839 in "The Zoology of Captain Beechey's Voyage*** etc." Although no locality was mentioned in the original description the only places touched by the "Blossom" at which a saltator of this type could have been collected were Acapulco, San Blas and Mazatlan on the west coast of Mexico. From just which of these seaports the type came there is no clue nor, for the present, does it make the slightest difference. What is of importance is that all of these places are within the range of Lawrence's *Saltator plumbiceps* and Vigors' description, brief as it is, is a good one when it comes to defining the essential characters of that form. A transcription of the original description on page 19 of the above work is given herewith. The italics are mine.

"Salt. *supra plumbeo-cinerea,* dorso caudâque olivascentibus; corpore infra rufescenti, *crisso saturatiore;* superciliis albescentibus.

Rostrum pedesque plumbei. *Tectrices alarum inferiores rufescenti-albidae.* Longitudo corporis, $7\frac{3}{4}$; *alae, a carpo ad apicem remigis tertiae,* $4\frac{1}{4}$; rostri, $\frac{7}{8}$; *caudae, 4;* tarsi, 1."

While the unitalicized characters might be applied equally well to either *grandis* or *plumbiceps,* the plumbeous-ash upperparts, contrasted crissum, rufescent-white under wing coverts and a tail slightly shorter than the wing would appear to clinch the matter when taken in connection with the itinerary of the "Blossom." Vigors' name was antedated by *Saltator rufiventris* of D'Orbigny and Lafresnaye (Mag. de Zool., 1837, 35) and therefore Gray as a matter of routine or even possibly aware of the distinguishing characters of Vigors' bird substituted (Gen. Birds, 2, 1844, 363) *Saltator vigorsii.* In view of the above I do not see how we are going to escape considering *plumbiceps* as a synonym of *vigorsii.*

A condensed distributional synopsis of the races of *Saltator grandis* is as follows: :

Saltator grandis grandis (Lichtenstein)

Atlantic slope of Mexico and Central America from Tamaulipas south to Costa Rica, exclusive of the Yucatan peninsula.

Although the type locality of Lichtenstein's *Tanagra grandis* was no more definite than "Mexico," the reprint of that author's "Preis-Verzeichniss mexicanischer Vögel" which appeared in the Journal für Ornithologie for 1863 (I have not seen the original) states that the collection on which the report was based was made by Deppe and Schiede. Sclater (Proc. Zool. Soc. Lond., 1856, 72) lists only Jalapa as the locality of the specimens of this species in the Berlin Museum where he examined Lichtenstein's types and Salvin and Godman (Biol. Centr.-Am., Aves, 1, 328) list Deppe as the collector of the Jalapa record. The type locality of the typical race would, therefore, certainly appear to be Jalapa, Vera Cruz, Mexico.

Saltator grandis yucatanensis Berlepsch

Yucatan peninsula.

Saltator grandis vigorsii Gray

Western Mexico, from Sinaloa south to Oaxaca.

Since the characters which distinguish *vigorsii* are quantitative only there would seem to be little point in attempting to maintain the west-Mexican form as a distinct species.

Saltator grandis hesperis Griscom

Pacific slope of Guatemala, El Salvador and Nicaragua.

Saltator grandis brevicaudus van Rossem

Pacific slope of northwestern Costa Rica and possibly the extreme southwestern part of Nicaragua.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 4, pp. 25-42, map, chart

THE COOL-WATER TIMMS POINT PLEISTOCENE HORIZON AT SAN PEDRO, CALIFORNIA

BY

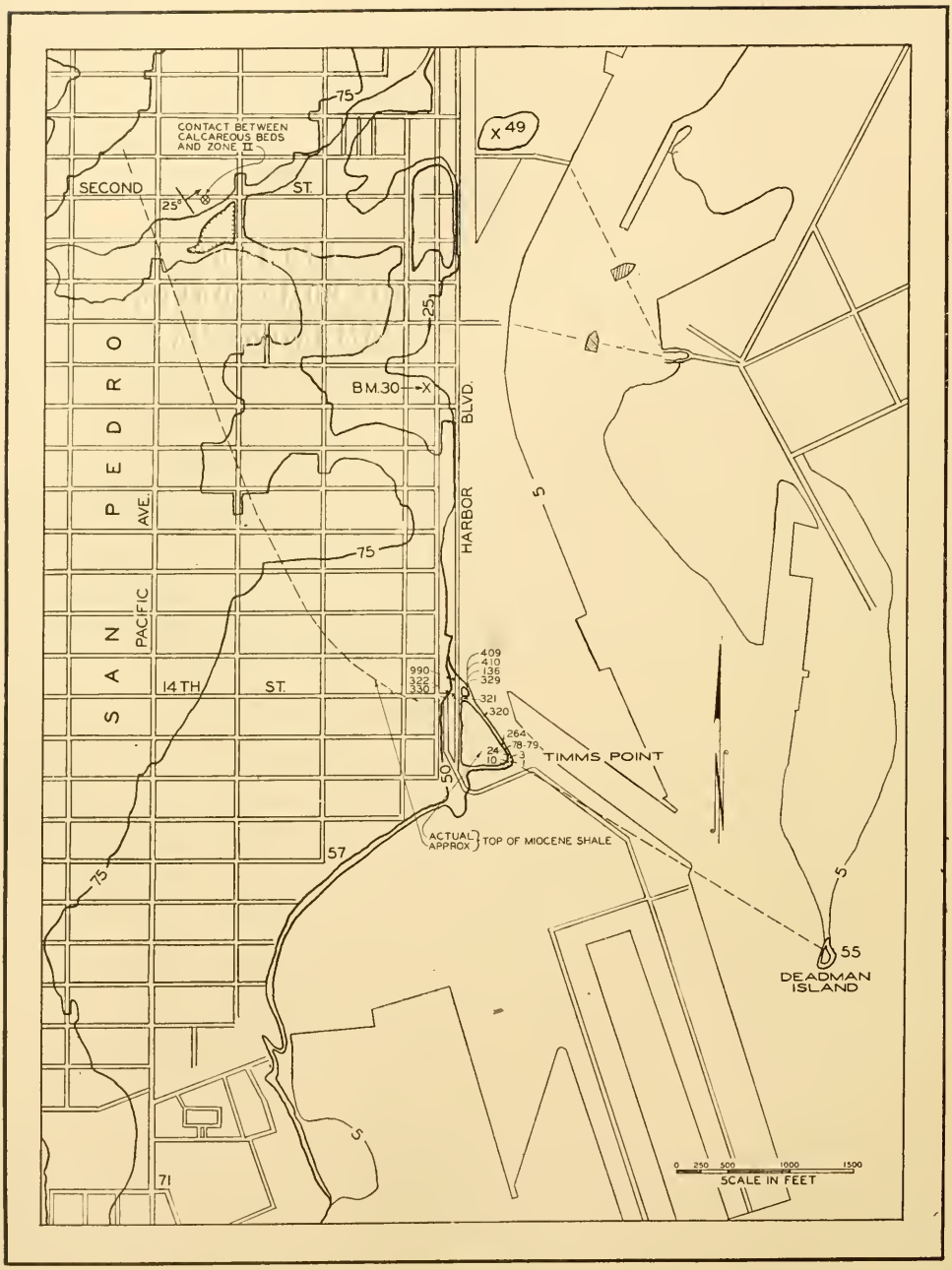
ALEX CLARK

California Institute of Technology

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

DECEMBER 19, 1931



Sketch map of the town of San Pedro, California, indicating collecting localities at Timms Point. (*Adapted from U. S. Geol. Survey, Wilmington Quadrangle*)

THE COOL-WATER TIMMS POINT PLEISTOCENE HORIZON AT SAN PEDRO, CALIFORNIA

BY

ALEX CLARK

California Institute of Technology

INTRODUCTION

Timms Point is located in the southeastern part of the town of San Pedro, Los Angeles County, California, just east of the south end of Harbor Boulevard, along the bluff facing the harbor. It is part of the abandoned sea cliff extending from a locality near Point Fermin northward along the east side of the town. The cliff is about forty feet high and its top represents the lowest of a number of marine terraces cut in the Palos Verdes Hills.

Since Arnold[1] studied the stratigraphy and faunas of San Pedro no account of the section exposed at Timms Point has been published. As at that time the exposures there were poor, only 28 species of mollusks were collected and no detailed observations could be made with reference to the stratigraphy. It, therefore, seems desirable to record the results of an examination of the stratigraphy and fossils.

A fauna of 155 species of mollusks, bryozoa, and brachiopods has now been collected and studied from the so-called Pliocene beds exposed at Timms Point. Foraminifera and ostracods, the former in great abundance, were collected, but not studied. A close scrutiny of the physical evidence and the fossils seems to indicate the presence of two minor faunal zones.

ACKNOWLEDGMENTS

I wish to express my appreciation to Dr. W. P. Woodring, formerly Professor of Invertebrate Paleontology at the California Institute of Technology, for suggesting the problem and for advice and criticism. Mr. A. M. Strong kindly identified *Diala marmorea* and *Barleeia haliotiphila*. Mr. George Willett, of the Los Angeles Museum, permitted

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[1] ARNOLD, DELOS & RALPH, "The Marine Pliocene and Pleistocene Stratigraphy of the Coast of Southern California." Jour. Geol., Vol. X, 1902, No. 2.

ARNOLD, RALPH, "The Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California." Mem. Calif. Acad. Sci., Vol. III, 1903.

comparison of some of the fossils with his Recent collection and offered suggestions as to their correct identification. Dr. U. S. Grant, IV, of the University of California at Los Angeles, criticized the faunal list. The Golisch collection of Recent shells, now at the California Institute of Technology was found indispensable in making comparisons with the fossils.

STRATIGRAPHY

The oldest rocks exposed at Timms Point consist of somewhat sandy, brown, fractured siltstone, intercalated with a few thin layers of hard yellow-weathering limestone, dipping northeastward at a somewhat steeper angle than the overlying beds. They are exposed on the west and south sides and in several places along the base of the east face of the bluff. The base of this formation is not exposed here, consequently the thickness is not known. Arnold referred these strata to the Miocene, without, however, any fossil evidence.

The beds to be described in detail are uncemented clayey fine sands and silts, predominantly yellowish with local finer gray streaks and patches. They lie unconformably on the irregular eroded surface of the Miocene shales. These beds strike N. 37° W. and dip northeastward at an angle of about 14°. The component of dip along the east face of the bluff is 8° where a thickness of about 30 feet is exposed. These beds, as well as similarly situated beds at Deadman Island, were considered of Pliocene age by Arnold.

About 200 yards north of the southeast corner of the bluff a concrete retaining wall several hundred feet long effectually hides the contact between the "Pliocene" and overlying beds. Unfossiliferous sands that are almost horizontal are found just north of the retaining wall. Farther north these sands are cross-bedded. The top of the section of tilted beds is at Second Street and Harbor Boulevard, where they consist of fossiliferous gray sands correlated by Arnold with the type Lower San Pedro of Deadman Island. It should be mentioned in this connection that Arnold[2] in his first paper designated Deadman Island as the type locality of the San Pedro series.

The horizontal Upper San Pedro beds truncate the whole section. At Timms Point, however, they are represented only by a very thin layer of Miocene shale and limestone cobbles exposed at the base of the soil

[2] ARNOLD, DELOS & RALPH, op. cit. 1902.

mantle on the west side of the bluff along Harbor Boulevard. The upper five or six feet of the cliff is made up of soil and alluvium containing a few kitchen-midden shells.

The best exposure of the "Pliocene" beds can be seen on the east face of the bluff just south of the concrete retaining wall. At this locality the section is as follows, beginning at the top:

Bed No.		*Thickness*
III.	Yellowish-gray massive dirty fine sands, slightly coarser than underlying sands. Contains a few scattered specimens of *Lucina annulata* and locally a lens of about 6 inches thick packed with greatly leached fossils	16′
II.	Yellowish to greenish brown fine silty sand, containing scattered well-rounded pebbles of hard shale and limestone. Overlaps onto "Miocene" shale southward. Lamellibranchs abundant, gastropods and foraminifera not so abundant. Decidedly cool-water fauna	1′-2′
I.	Yellowish massive clayey silts with finer gray streaks and pockets. Somewhat marly in places near base. Numerous bored pebbles of the underlying shale and a few phosphatized pebbles are found at the base. Basal portion consists almost entirely of foraminiferal remains with some small mollusks. Toward middle of bed, mollusks, particularly gastropods, become more abundant. Bryozoa abundant locally toward south end of point. Fauna indicates somewhat warmer facies	12′
	Total	30′

Prior to the removal of several feet of material from the bluff at the southeast corner of Timms Point, the overlap of Bed No. 2 could be observed, where it rested directly on the Miocene shale. The same relation can still be seen on the west side of the bluff. This overlap may be due to an irregular surface of deposition and probably has little time significance, but it is interesting to notice that the faunas of Bed No. I and Bed No. II are considerably different, as will be indicated below.

FAUNA

Arnold listed the following 28 species from Timms Point:

LAMELLIBRANCHIATA

Callista subdiaphana
Leda taphria
Lucina acutilineata
Nucula castrensis
Pecten caurinus
Pecten jordani
Protocardia centifilosa
Solen sicarius
Thyasira bisecta
Thracia trapezoides
Thyasira gouldii
Venericardia barbarensis
Venericardia ventricosa

Gastropoda

Bittium asperum	Drillia torosa	Natica clausa
Chrysodomus tabulatus	Fusus barbarensis	Olivella biplicata
Columbella gausapata	Nassa mendica	Terebra simplex
Columbella var. carinata	Nassa cooperi	Trophon stuarti
Conus californicus	Nassa perpinguis	Turritella cooperi

Mitrella carinata and *Terebra "simplex"* were not found during this study. In his paper on the California Pectens, Arnold[3] listed *Chlamys hastatus navarchus* (Dall) from Timms Point. *"Tritonofusus" riversi* Martin was described by Martin[4] from the same locality. Neither of these species was encountered.

In the accompanying faunal list from the Timms Point beds, the specific nomenclature and, for the most part, the generic nomenclature follows that of Dall.[5] The present range of species is also taken from Dall's paper. The letter R indicates that a species is represented at a locality by three or less specimens. The letter C denotes *common* (3 to 20 specimens). The letter A indicates that 20 or more specimens were found at a locality. In the column marked "Living," species now found only north of Point Conception are indicated by the letter N. Species ranging only south of that locality are designated by the letter S. Species which range both north and south of Point Conception are indicated by an X. Species which are believed to be extinct are designated with the letter E.

The column marked "Calcareous Beds" includes the species common to Timms Point and the faunas as recorded by Woodring[6] from the calcareous beds and marls exposed at Second Street and at Hilltop Quarry. The species in the column marked "Timms Point Formation at Second Street" are those found also by Woodring in the silts above the calcareous beds. In the remaining three columns, Arnold's lists were consulted, augmented in the case of the "Lower San Pedro" column by species listed by Oldroyd.[7] Canu and Bassler's[8] list of bryozoa from the Deadman

[3] Arnold, Ralph, "The Tertiary and Quaternary Pectens of California." U. S. Geol. Survey, Prof. Paper No. 47. 1906

[4] Martin, Bruce, "Descriptions of New Species of Fossil Mollusca from the Later Marine Neocene of California." U. of Cal. Pub. in Geol., Vol. 8, No. 7. 1914.

[5] Dall, W. H., Bulletin 112, U. S. Nat. Mus. 1921.

[6] Woodring, W. P., "Warm-Water Faunas of the So-Called Pliocene of San Pedro" (abstract). Bull. Geol. Soc. Am., Vol. 41, No. 1. 1930.

[7] Oldroyd, T. S., "The Fossils of the Lower San Pedro Fauna of the Nob Hill Cut, San Pedro, California." Proc. U. S. Nat. Mus., Vol. 65, Art. 22, 1924.

[8] Canu, F. and Bassler, R. S., "Later Tertiary and Quaternary Bryozoa of North America." Bull. 125, U. S. Nat. Mus. 1923.

CHECK LIST OF FOSSILS FROM THE TIMMS POINT FORMATION AT TIMMS POINT

	ZONE I							ZONE II								Position Uncertain		Calcareous Beds	Timms Pt. fm. at Second St.	Deadman I. "Pliocene"	L. San Pedro	U. San Pedro	Living
			Bed No. I						Bed No. II				No. III										
GASTROPODA	264	329	3	78	136	320	330	10	24	77	321	322	410	409	990	1	274						
Acmaea insessa (Hinds)			R						R			R		R				X		X	X	X	X
Diadora aspera (Eschscholtz)					R																X	X	X
Puncturella galeata (Gould)	C	R	R		R													X		X	X		X
Puncturella cucullata (Gould)	R		R		R	R	R					R					R			X	X	X	X
Tegula montereyi (Kiener)	R		R					R		R		R				R		X	X	X	X	X	X
Calliostoma annulatum (Martyn)			C													R	R					X	X
Calliostoma canaliculatum (Martyn)			R		R					R		R				R		X	X	X	X	X	X
Calliostoma costatum (Martyn)								R										X				X	X
*Calliostoma sp.		R																X					
Cidarina cidaris (A. Adams)	R				R		R			R		R								X			X
Solariella peramabilis Carpenter	R		R	R		R		R		R		R							X	X			X
Turcica caffea Gabb			C	R												C	R			X			S
Margarites optabilis (Carpenter)			R														R	X			X		S
Margarites pupillus (Gould)												R						X		X			X
Astraea inaequalis (Martyn)	R		R	C	C	R	R		R							R		X			X	X	X
Homalopoma bacula (Carpenter)		C																X			X	X	X
Homalopoma carpenteri (Pilsbry)				R				R								R		X			X	X	X
Tricolia pulloides (Carpenter)		C																X					X
*Turbonilla cf. pedroana Dall and Bartsch			R																				X
Epitonium indianorum (Carpenter)			R		R		R				R	R							X	X	X	X	X
Tectonarica clausa (Broderip and Sowerby)			C		A	R	R	C	R			R					R	X	X	X	X	X	X
Euspira lewisii (Gould)					C	R		R		R								X				X	X
Neverita reclusiana (Deshayes)	R							R		R		R						X	X	X	X	X	X
Crepidula princeps Conrad	R				R																		E
Crepidula adunca Sowerby					R													X			X	X	X
Crepidula lingulata Gould	R		C		C	R	R					R				R		X			X	X	X
Crepidula nummaria Gould					R		R			R								X			X	X	X
Calyptraea mamillaris Broderip							R														X	X	N
Rissoina dalli Bartsch		R																X			X		S
Barleeia haliotiphila (Carpenter)		C																X					X
"Diala" marmorea Carpenter		C																X					X
Spiroglyphus lituellus (Mörch)																	R	X				X	X
Turritella cooperi Carpenter			A		C	R	C	C	R		R	C		R		A	A	X	X	X	X	X	X
Turritella jewettii Carpenter			R	R	C	C	R	C	R	R		R				R	R	X		X	X	X	S
Cerithiopsis necropolitana Bartsch			R																		X		E
Bittium asperum (Gabb)	C	C																X		X	X	X	S
Bittium attenuatum boreale Bartsch			R				R										R						N
Bittium catalinense Bartsch	R																	X			X		S
Bittium giganteum Bartsch				R				C	C	C								X	X		?		E
Bittium larum Bartsch	R		R														R						S
Bittium ornatissimum Bartsch	R		C		C		C					R?						X			X		E
Bittium rugatum Carpenter								R	R			R						X	X		X	X	S
*Bittium cf. rugatum Carpenter					C	C	C	R				R					C	X					
Bittium serra Bartsch							R																S
*Bittium sp. indet.															C								
Alabina californica (Dall and Bartsch)		R																X			X		E
Fusitriton oregonensis (Redfield)			R		R	R	R	R	R			R				R	R	X		X	X	X	X
Tritonalia barbarensis (Gabb)					R	R												X			X		X
Boreotrophon multicostatus (Eschscholtz)					C	R														X	X		X
Boreotrophon orpheus praecursor (Arnold)	R	R	C		C	R	R		R								R	X		X	X		E
Boreotrophon pacificus (Dall)	R																			X	X	X	X
Boreotrophon stuarti (E. A. Smith)					R													X	X	X	X		X
Mitrella gausapata (Gould)	R		R	R	C			C	R			C						X	X	X	X	X	X
Mitrella tuberosa (Carpenter)		C																X			X	X	X
Amphissa reticulata Dall	R	R	C		C	R												X	X				X
Nassarius cooperi (Forbes)	R		C		C													X	X	X	X	X	X
Nassarius mendicus (Gould)			R		C	R						R					R	X	X	X	X	X	X
Nassarius perpinguis (Hinds)			R		C	R		R									R	X	X	X	X	X	X
Cantharus fortis (Carpenter)					R													X					E
Neptunea tabulata (Baird)			R		C	R		R		R		R	C	R			R	X	X	X	X		X
*Neptunea ? sp.								R															
"Exilia" rectirostris (Carpenter)			R		C				R	R		R				R	R			X	X	X	X
Barbarofusus barbarensis (Trask)	R		R	R	A	C	R	R				R				R	C	X	X	X	X	X	X
Barbarofusus kobelti (Dall)					R																		X
Mitra idae Melvill												R					R	X			X	X	X
Cypraeolina pyriformis (Carpenter)		R																X					X
Olivella biplicata Sowerby	C		C	R	R	C	R			R		R		R			C	X	X	X	X	X	X
Olivella pedroana (Conrad)	R					R		R				R						X		X	X	X	X
Admete couthouyi gracilior (Carpenter)																	R	X			X		X
Conus californicus Hinds					R	R		R										X	X	X	X	X	X
Antiplanes perversa (Gabb)	R		R		C	R	R	R	R		R	C					R	X		X	X	X	X
Antiplanes rotula Dall			R			C						C								X	X		X
Antiplanes santarosana Dall									R	R										X	X		S
Clathurella crystallina (Gabb)					R	R												X					S
Borsonella barbarensis Dall			R			R														X	X		X
Borsonella bartschi (Arnold)	R		C		C	C	R										R	X		X	X		S
"Clathrodrillia" renaudi (Arnold)					R															X	X		S
Pseudomelatoma merriami (Arnold)			R																	X	X		X
Pseudomelatoma moesta (Carpenter)			R															X					X
"Taranis" strongi (Arnold)			R						R									X		X			X
*"Clathurella" sp.					R																		
"Lora" viridula (D. Fabricius)			R		R													X		X	X		N
"Lora" tabulata (Carpenter)			R		R													X					N
"Mangilia" oldroydi (Arnold)			R		R													X			X		E
Acteocina culcitella (Gould)			C			R	R											X	X		X	X	X
Acteocina harpa (Dall)			R		R	R												X		X	X	X	X
SCAPHOPODA																							
Cadulus fusiformis Pilsbry & Sharp	R		R															X	X		X		X
Dentalium neohexagonum Sharp & Pilsbry			R		R												R	X		X	X	X	X
LAMELLIBRANCHIATA																							
Acila castrensis (Hinds)			C	R	C		C	R	R		R	C				C	C	X	X	X	X		X
Nuculana minuta praecursor (Arnold)	C		C				R										R	X	X	X	X		E
Nuculana taphria (Dall)			R					C	R	R	C	C						X	X	X	X	X	X
Yoldia scissurata Dall			R		R					R		R				R		X			X		X
Pecten diegensis stearnsii Dall			R			C	R	R			R					R		X		X			E
"Pecten" caurinus Gould			R	R	R	R		C	R	R	R	C		R	R	C	R		X	X	X	X	N
Chlamys hastatus hastatus (Sowerby)			C		R	R	C			R	R	R		R		C	C	X	X	X	X	X	X
Chlamys islandicus hindsii (Carpenter)					R													X		X			X
Chlamys jordani (Arnold)	R		R	R	C	R	C	C	C	C	R	C		C		R	C		X	X	X		N
Hinnites giganteus (Gray)													R								X	X	X
Monia macroschisma (Deshayes)			R		C	R	R	R	R	R						R		X				X	X
Volsella fornicata (Carpenter)			R	R						R		R				R			X		X	X	X
Crenella columbiana Dall						R												X			X		X
Thracia trapezoides Conrad			R	R	R	R	R	R				R			R	C			X	X			N
*Cyathodonta cf. pedroana Dall								R													X		S
Pandora filosa (Carpenter)						R				R											X		X
Pandora grandis Dall								C		C		C				R			X				N
Poromya tenuiconcha Dall	R				R													X					X
Cuspidaria pectinata (Carpenter)			R															X			X		X
Verticordia ornata (D'Orbigny)			R															X			X		S
Cardita barbarensis (Stearns)			R		R		R													X	X	X	S
Cardita ventricosa Gould	R		C	R	A		C	A	C	C	R	A	C	C		C	A	X	X	X	X	X	X
Pseudochama exogyra (Conrad)			C		R		R					R					R	X				X	X
Thyasira disjuncta (Gabb)												C		A						X			N
Thyasira gouldii (Philippi)			R					R	C	C		C	C					X	X	X	X	X	X
Axinopsis viridis Dall																	R	X	X				X
Diplodonta orbella (Gould)																R		X			X	X	X
Lucina annulata Reeve	R		R	R	R		R	A	C	R	C	C	A	C		R	C	X	X	X	X	X	X
Lucina californica Conrad			R				R			R		R				R		X		X	X	X	X
Lucina nuttallii Conrad							R					R							X		X	X	S
Lucina tenuisculpta Carpenter						C											R	X	X		X	X	X
Trachycardium quadragenarium (Conrad)					R							R				C		X				X	S
Cerastoderma corbis (Martyn)					R			R	R	C		R				R	R	X	X		X	X	X
"Protocardia" centifilosa (Carpenter)	R		C		C		R	R		R	R	C				C	C	X		X	X		X
Saxidomus nuttallii (Conrad)					R											R		X		X	X	X	X
Venus perlaminosa (Conrad)								R		R	R							X					E
Venerella subdiaphana (Carpenter)				C	R			R	R	C	R	R	R	C		C	R		X	X			X
Psephidia ovalis Dall		R	C		R	C											C	X	X				X
Psephidia cymata Dall																	C	X	X				S
Tellina buttoni Dall																	R	X	X		X	X	X
Macoma inquinata (Deshayes)						R														X	X	X	X
Macoma calcarea Gmelin (small var.)			C	R	C			A	C	C	R	C		R	A	C	C	X	X	X	X		N
Semele incongrua Carpenter					R	R										R		X	X		X		X
Semele rubropicta Dall											R					R					X		X
Solen sicarius Gould			R	R	R					R		R				C		X	X	X	X	X	X
Schizothaerus nuttallii (Conrad)			R																			X	X
Mya truncata (Linné)										R													N
Panopea generosa Gould				R	C			R			R					R		X	X	X	X	X	X
Panomya ampla Dall					R			R				R				C			X	X	X		N
BRACHIOPODA																							
Laqueus californicus vancouverensis Davidson							R			R							R			X			N
Dallinella cf. hempilli (Dall)				R						R									X				E
BRYOZA																							
Cellaria mandibulata Hincks	R		R					R									R						S
Conopeum barbarensis (Gabb & Horn)			R																				E
Entalophora fasciculifera Canu & Bassler																	C			X			E
Filisparsa clarki Canu & Bassler			C														C						E
Idmonea californica D'Orbigny	R		A				A										A			X			E
Lagenipora spinulosa Hincks			R														R			X			X
*Lichenopora cf. californica Conrad			R														R						E
Membranipora tuberculata (Bosc)			R																				X
*Microporella cf. ciliata Linné			R														R			X			X
Microporella eustomata Gabb & Horn			R														R						E
Phidolopora labiata Gabb & Horn			R																	X			E
Smittina discoidea Canu & Bassler			R																				E
Tubucellaria punctulata (Gabb & Horn)			C				A										A			X			E
CRUSTACEA																							
Balanus sp.								R															
Cancer sp.			R																				
PISCES																							
Galeus zyopterus? Jordan & Gilbert												R											X

*Species not included in computing percentage of extinct species

Island "Pliocene" was also used in determining the geologic range of these forms.

Following is a list of California Institute of Technology collecting localities at Timms Point:

264.—200 feet north of southeast corner of Timms Point and on the east face. Basal 2 feet of Bed No. I resting directly on Miocene shale. Foraminifera extremely abundant.

329.—North end of east face of bluff just south of concrete retaining wall. Base of section same as at 264 but a hard limey layer containing broken fossils intervenes between the abundant forams and the contact with the Miocene. No species were identified from the limey layer.

3.—East face of bluff 50 feet north of southeast extremity. Bed No. I. Bryozoa extremely abundant.

78.—East face of bluff 150 feet north of southeast extremity. Bed No. I. Fossils came from 4 feet below Bed No. II, which is highest fossil bed exposed at this locality.

136.—Same locality as 329 but in middle and upper portion of Bed No. I.

320.—East face of bluff 450 feet north of southeast extremity and just south of small red shack. Middle and upper portions of Bed No. I.

330.—Low bank along sidewalk on west side of Harbor Boulevard at the end of Fourteenth Street. Bed No. I. Bryozoa abundant.

10.—Near top of bluff at, and just north of, southeast extremity. Uppermost fossil bed rests on Miocene shale here. This is Bed No. II.

24.—Same locality and bed as 10, but 30 to 40 feet north. Here several feet of Bed No. I intervene between Bed No. II and the Miocene contact.

77.—Same locality as 78, but 4 feet stratigraphically higher in Bed No. II.

321.—East side of Harbor Boulevard opposite end of Fourteenth Street. Bed No. II resting directly on Miocene,

322.—Same locality as 330, but about 4 feet stratigraphically higher and on gentle slope above the bank. Bed No. II.

410.—Same locality as 329, but about 12 feet stratigraphically higher, in Bed No. II. There are abundant fossils at this locality, but only one was collected because the bed can be definitely traced southward to a more accessible collecting locality.

409.—Same locality as 329, but about 14 feet stratigraphically above, in thin fossil lense near base of Bed No. III.

990.—150 feet north of 330 on west side of Harbor Boulevard on slope about 10 feet above sidewalk. 30 feet stratigraphically above Bed No. II. *Thyasira disjuncta* abundant here.

1.—Southeast corner of bluff at base of exposed section. Stratigraphic position uncertain due to slumping.

274.—Timms Point along the east face. Collected by students from various localities along the east face of the bluff.

FAUNAL SUMMARY

	Bed No. I	*Bed No. II*	*Bed No. III*	*Total*
Gastropods	78	38	5	86
Lamellibranchs	38	32	10	49
Scaphopods	2	0	0	2
Brachiopods	2	2	0	2
Bryozoa	13	2	0	13
Crustacea	1	1	0	2
Pisces	0	1	0	1
TOTAL	134	75	15	155
Specifically identifiable mollusks	114	66	14	130
Extinct mollusks	10	5	.....	11
Percentage of extinct mollusks	8.8	7.6	.....	8.5
Percentage of extinct bryozoa	.....	.....	.....	72.7

Bed No. I contains 69 species not found in the beds above. Bed No. II contains 13 species not found in Bed No. I. All the species recognized in Bed No. III are present in Bed No. II.

Several species are present in Bed No. II that are not found living south of Oregon today and some of these have Puget Sound as their southern limit. The species are as follows: *Pandora grandis, Thyasira disjuncta, Mya truncata, "Pecten" caurinus, Chlamys jordani, Thracia trapezoides,* and *Panomya ampla.* The first three of these species were not found in Bed No. I.

Several fossils occur at locality 990, 30 feet above Bed No. II and evidently in Bed No. III. The presence among them of *Thyasira disjuncta, Thracia trapezoides,* and *Pecten caurinus* indicates that this bed also represents the typical cool water zone present in Bed No. II.

Bed No. I carries a number of species whose present range does not extend north of Point Conception. On the other hand most of these species range south along the coast of Lower California, thus indicating warm-water rather than cool-water affinities. Species living only south of Point Conception can certainly be considered to belong to a warmer-water fauna than those found living only north of Siletz Bay, Oregon. The species not found north of Point Conception are as follows: *Turcica*

caffea, Tricolia pulloides, Rissoina dalli, Bittium larum, Bittium catalinense, Borsonella bartschi, Clathrodrillia renaudi, Verticordia ornata, Lucina nuttallii, Psephidia cymata, Turritella jewetti, Cardium quadragenarium, and *Cellaria mandibulata.* All but the last three of these species were found only in Bed No. I.

Several relatively warm-water species occur in Bed No. II, but they are rare as compared to their occurrence in the bed below. The simplest explanation of their presence in a cool-water fauna is that they have been derived from the lower bed by reworking. Little concrete evidence is available to support such an explanation except that the specimens of *Turritella jewetti* appear to be considerably worn and the *Cardium quadragenarium* is represented only by worn fragments. The fact that shells are worn or broken cannot be taken as conclusive proof that they are reworked from an older deposit, as it is quite common to find such specimens of Recent shells along the beach where wave action has worn and broken them.

The presence of this markedly cool-water fauna in Beds II and III cannot be entirely accounted for by assuming that it represents a deeper water deposit than the underlying warmer-water fauna. The somewhat coarser materials in Beds II and III, the presence of the overlap, and the character of the fauna indicate that this bed was laid down in shallower water than Bed No. I. The conclusion follows that the cooling of the water was due to a cooler climate, rather than to an increase in depth of the water. Such a marked change in climate was undoubtedly due to the advent of a glacial stage.

The occurrence of such cool-water species as *"Pecten" caurinus, Chlamys jordani,* and *Thracia trapezoides* in Bed No. I with a fauna that has a warmer aspect is not readily understood. A number of explanations may be considered:

1. Bed No. I and Bed No. II both represent cool-water facies and all the warm-water species are reworked from underlying beds not present at Timms Point, but occurring at Second Street in San Pedro about a mile away, as described by Woodring.

2. Bed No. I represents a warm-water horizon and the cool-water species have been reworked from a lower cool-water horizon not present here.

3. Bed No. I contains more than one zone of alternating cool and

warm-water facies, thus giving the appearance of a mixture of cool and warm-water species.

4. During deposition of Bed No. I the waters were becoming cooler and cool-water species began to appear before the warmer water types were driven out by the unfavorable environment. This postulates an interfingering of two faunas such as is observed at the border of two faunal provinces at the present time.

The principal objection to the first explanation is that a number of warm-water species are present in Bed No. I which do not occur in the underlying warm-water beds at Second Street. *Turcica caffea,* which is abundant in Bed No. I at Timms Point, but not found at Second Street or any other underlying warm-water beds exposed around San Pedro, is a notable example. There is a possibility that the warm-water forms in Bed No. I were derived from an unknown set of beds below that are now removed by erosion.

The second explanation offered has little support in the light of present knowledge of beds underlying the Timms Point section. No fauna occurring below the Timms Point beds is known in the vicinity of San Pedro that contains *"Pecten" caurinus* or *Thracia trapezoides,* two of the notably cool-water species occurring in Bed No. I. It is possible here also that such a zone has been removed by erosion or cannot be found due to lack of exposures.

No confirmation of the third explanation was obtained from the field evidence. No break in sedimentation or slightest indication of the presence of more than one bed in Bed No. I at Timms Point could be detected.

Arnold[9] used the fourth explanation in connection with the association of warm- and cool-water types in the Lower San Pedro sands. Later Oldroyd[10] employed the same reasoning in his discussion of the Lower San Pedro fauna at Nob Hill, San Pedro. Bed No. I contains a fauna indicative of several fathoms depth at the time of deposition. This may account for the early appearance of some of the cool-water forms that presumably were beginning to arrive from the north. The warmer-water forms had not yet retreated southward. Whether such a mingling of species of different environments can take place, is not at present proven.

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[9] Arnold, Ralph, op. cit. 1903.

[10] Oldroyd, T. S., op. cit. Page 2.

In view of the present limited knowledge regarding the "Pliocene" sections in and around San Pedro, it seems to be the most reasonable theory.

RELATION TO SECOND STREET SECTION

The section along Second Street has been referred to above. In order to bring out its relations to the beds at Timms Point, a brief description of the stratigraphy there seems warranted. Woodring[11] has described the section and studied the fossils. The base of the section is not seen in this vicinity due to lack of exposures. The Miocene shale outcrops in the first alley west of Pacific Avenue just south of Second Street. No exposures are available from this point eastward for at least a hundred yards. The first exposure of the "Pliocene" beds occurs on Second Street half a block east of Pacific Avenue. The lowest beds exposed in the section occur in a small quarry in the alley just south of the street. They consist of fossiliferous marly beds containing a relatively warm-water fauna. These beds are overlain by calcareous beds also carrying a warm-water fauna. The total thickness of marl and calcareous beds exposed is 68 feet. These faunas are warmer in facies than that in Bed No. I at Timms Point as indicated by the entire absence of *"Pecten" caurinus* and *Thracia trapezoides*. Disconformably overlying the calcareous beds are dirty silts and sands carrying the typical cool-water fauna corresponding to that in Beds II and III at Timms Point. These beds also have the lithologic characters of Beds II and III. Three fossiliferous beds occur on the south side of the street in this upper division separated by intervals of barren sand. Above these fossiliferous beds the deposits become thin-bedded and intercalated with thin beds of clean sand and the dip decreases from about 25° northeastward to less than 15°. These beds grade upward into the same cross-bedded sands as those seen north of the concrete retaining wall previously mentioned. Another break in the exposures occurs just west of Beacon Street and no more exposures are found until the Lower San Pedro fossiliferous sands are encountered at Second and Beacon Streets.

Besides the lithologic and faunal similarity of the cool-water horizons at the two localities, the field evidence supports the conclusion that they represent the same zone. The strike of Bed No. II at Timms Point is N. 37 W., whereas the strike of the contact between the Miocene shale and the overlying silts is about N. 45 W. This divergence in a north-

[11] WOODRING, W. P., op. cit. The thicknesses of the units in the Second Street section were kindly supplied by Dr. Woodring.

westerly direction permits the appearance of other beds below Bed No. II as the contact is followed in the direction of Second and Pacific Streets.

An examination of collections from the basal two feet of Bed No. I indicated a difference which was at first thought to represent a separate zone. Several species of small gastropods are found in considerable abundance, such as: *Homalopoma bacula, Tricolia pulloides, Rissoina dalli, Diala marmorea, Bittium asperum, Bittium catalinense, Alabina californica, Mitrella tuberosa,* and *Cypraeolina pyriformis.* These species occur in pockets and patches at or near the base, but were not seen farther up in the bed. Woodring has found these species to be quite common in the calcareous beds below the cool-water horizon at Second Street. At places along the bluff at Timms Point the base of Bed No. I carries virtually no sand or silt but consists of a concentrate of nearly pure foraminiferal remains. A small pebble of calcareous material containing several small species of gastropods common in the calcareous beds on Second Street, was found five feet above the base of Bed No. I at C. I. T. locality 320. No calcareous lenses or beds were observed in the silts at Timms Point, although the lower portion of Bed No. I is somewhat marly. All this evidence taken together indicates that the entire section at Timms Point lies above the calcareous beds on Second Street and that Bed No. I carries material reworked from the calcareous beds, that is, Bed No. I at Timms Point falls between the calcareous beds and the cool-water overlying sands on Second Street. It is possible that part of the calcareous beds grade laterally into the silts found in bed No. I at Timms Point. If this change actually does take place, then the fauna would necessarily change also, since there is a considerable difference in the faunas at the two localities. Such a possibility need not be seriously considered.

Relation to Deadman Island Section

Unfortunately I did not have the opportunity to visit Deadman Island, before it was blasted away. Any attempt, therefore, to compare in detail the section there with that at Timms Point will not be entirely satisfactory. The faunas taken as a whole compare very closely, except that only 87 species were recorded by Arnold from the Deadman Island "Pliocene," though more species have very likely been added by the collecting of Crickmay[12] and his students.

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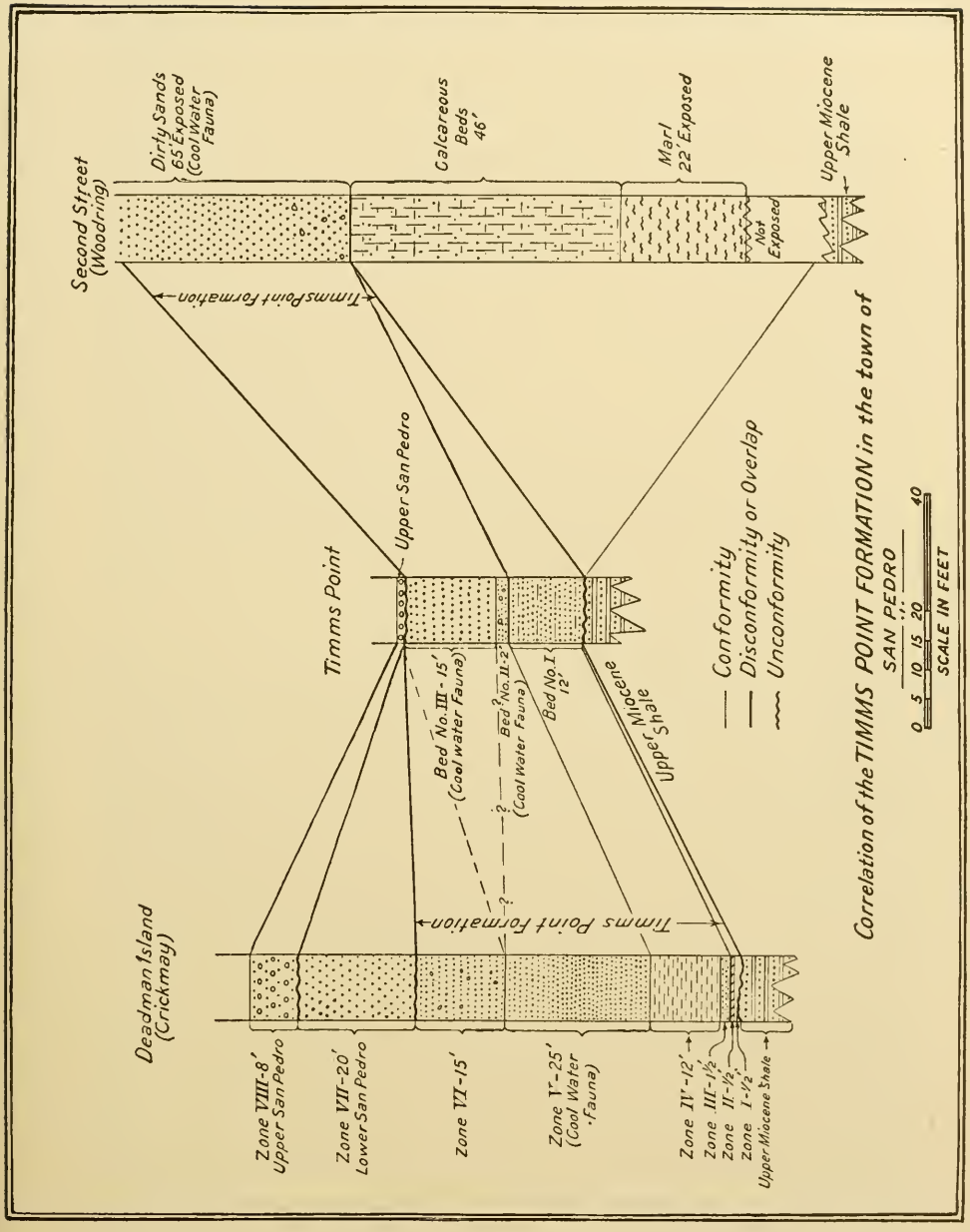
12 Crickmay, C. H., "The Anomalous Stratigraphy of Deadman's Island, California." Jour. Geol., Vol. XXXVII, 1929, No. 7.


Second Street (Woodring)
Dirty Sands 65' Exposed (Cool Water Fauna)
Calcareous Beds 46'
Marl 22' Exposed
Not Exposed
Upper Miocene Shale
Timms Point formation
Upper San Pedro
Timms Point
Bed No. III - 15' (Cool water Fauna)
Bed No. II - 2' (Cool Water Fauna)
Bed No. I 12'
Upper Miocene Shale
Conformity
Disconformity or Overlap
Unconformity
Deadman Island (Crickmay)
Timms Point formation
Zone VIII - 8' Upper San Pedro
Zone VII - 20' Lower San Pedro
Zone VI - 15'
Zone V - 25' (Cool Water Fauna)
Zone IV - 12'
Zone III - 1½'
Zone II - 1½'
Zone I - 1½'
Upper Miocene Shale
Correlation of the TIMMS POINT FORMATION in the town of SAN PEDRO
0 5 10 15 20 40
SCALE IN FEET

Considered in detail, the sections differ somewhat. At Timms Point, the section can only be divided into three distinct beds representing two different faunal zones. On the other hand, Crickmay divides the Deadman Island "Pliocene" section into six zones. These zones do not appear sufficiently distinctive faunally to be of more than local importance. In most cases, the indicated temperature differences between the zones are minor and could readily be accounted for by local changes in current or depth. His Zones 1, 2, and 3 were not recognized at Timms Point. Since Crickmay found that Zone 3 overlaps Zones 1 and 2 on Deadman Island, they are very likely overlapped at Timms Point. His Zone 3 contains no distinctive fossils which are not present in Bed No. I at Timms Point, so is included with Zone 4 as the correlative of Bed No. I. Crickmay's Zone 4, characterized by abundant forams, bryozoa, and numerous small mollusks, is readily recognized at Timms Point as Bed No. I. His Zone 5 is, as he points out, "the only decidedly cool-water fauna" in this region. This fauna is represented at Timms Point by Beds II and III. His Zone 6 contains no unique forms by which it may be recognized at Timms Point.

AGE

It is difficult to accurately estimate the percentage of extinct species when some of the determinations are doubtful as is the case here. A number of the smaller mollusks cannot be satisfactorily identified without comparison with type material. Very likely some of the small forms present here, and not recorded as living, actually are to be found in the Recent fauna but under a different name. No attempt has been made here to deal with synonomic problems. Leaving out of consideration the more doubtful species (indicated in the faunal list by an asterisk), the percentage of extinct mollusks for the two zones at Timms Point is found to be 8.5%. This figure is much less than that given by Arnold for the "Pliocene" (17.3%). It is to be expected that a more detailed comparison of the fossil with the living specimens will reduce the figure. A more complete fauna, including a number of species known hitherto only in the Recent or San Pedro faunas, also tends to lower the percentage of extinct species. The species found at Timms Point which have not previously been reported as fossils are: *Axinopsis viridis, Barleeia haliotiphila, Bittium attenuatum boreale, Bittium larum, Bittium serra, Clathurella crystallina, Diala marmorea, Poromya tenuiconcha,* and *Tricolia pulloides.* Species found which have not previously been reported from below the Lower San Pedro are: *Alabina californica, Astraea inaequalis, Bittium*

giganteum, Bittium ornatissimum, Crepidula nummaria, Cuspidaria pectinata, Margarites optabilis, Pandora filosa, Rissoina dalli, Spiroglyphus lituellus, and *Verticordia ornata.*

The percentage of extinct species of bryozoa present in the Timms Point beds is 72.7%. This result is strangely at variance with the figure for the mollusks. The extremely large percentage of extinct species of bryozoa can hardly be due to the more rapid change in time of these organisms as compard to that of mollusks. The Recent bryozoa have not been studied or reported to the extent of the Recent mollusks. Consequently, it may be anticipated that many of the bryozoa recorded here as being extinct will be found living when more attention is paid to the Recent members of this group.

An age determination on the basis of extinct species is not entirely trustworthy, in that the concept of the limits of a species changes from time to time and varies with the individual paleontologist. Increasing data on Recent species changes the percentages also. It has usually been considered, however, that a fauna containing 10% or less of extinct species is Pleistocene in age.

If one considers the total fauna at Timms Point together with that of the underlying Second Street marls and calcareous beds, it will be found that it corresponds quite well to that of the Lower San Pedro as given by Arnold. Both percentage of extinct species and the percentage of species common to the two indicates the close relationship. Arnold placed the division between Pliocene and Pleistocene below the 12 feet of Lower San Pedro beds on Deadman Island and considered the 45 feet of sands underlying them as Pliocene. The reasons given for so doing were: (1) angular unconformity there between the two sets of beds; (2) Percentage of extinct species ("Pliocene" 17. 3% and Lower San Pedro 12.5%); (3) Faunal differences between the two.

There is no means of finding the relations between these two sets of beds on the mainland due to lack of exposures at critical points. Arnold, however, indicated that they are probably comformable at the place where the concrete retaining wall now stands just north of Timms Point. The marked faunal difference between the "Pliocene" and Lower San Pedro does not seem to have any time significance, but rather represents a facies difference due to difference in depth of water at the time of deposition and to difference in temperature. Warmer water zones below the typical cool-water zone at Timms Point compare more favorably in faunal content with the Lower San Pedro than with the immediately overlying fauna of

cool-water aspect. Faunal and stratigraphic breaks are present within the "Pliocene" section in the vicinity of San Pedro which may well be as great as that between the "Pliocene" and Lower San Pedro on Deadman Island. The conclusion drawn from such reasoning is that the "Pliocene" beds are part of the same series as the Lower San Pedro horizon and are little older, that is, they are early Pleistocene in age. Tieje[13] was the first writer to intimate that the "Pliocene" cool-water horizon belongs in the Pleistocene since Arnold placed it in the Pliocene.

Correlations by means of comparisons of faunal lists only, are usually found to be misleading. The most satisfactory method is to directly compare the material from the sections involved. For this reason no attempt will be made to correlate in detail the section described here with other localities of approximately the same age. It is clear, however, that the name Santa Barbara formation cannot be applied to the Timms Point beds, due to the presence of several extinct species in the lower portion of Santa Barbara section at Santa Barbara and their absence in the Timms Point beds. Notable among these is *Pecten bellus* Conrad. It is believed that at least the lower part of the Santa Barbara section is older than the Timms Point beds. The name San Diego formation is likewise inappropriate. The percentage of extinct species in the San Diego Pliocene is between 30% and 40% or thereabouts, which is in sharp contrast to the 8.5% extinction for Timms Point. The presence of a number of extinct species in considerable abundance at San Diego and unknown in the "Pliocene" in the vicinity of San Pedro, together with the absence in the San Diego Pliocene of the characteristic cool-water species of the Timms Point beds, is further evidence that the San Diego formation is older than the Timms Point beds.

In view of the lack of a convenient term for this horizon, which has variously been called Santa Barbara, San Diego, and Deadman Island Pliocene, the name Timms Point is proposed for the silts and sands overlying the Miocene shale and underlying the Lower San Pedro sands, with the section described at Timms Point as the typical section. Whether these beds carrying a cool-water fauna are to be considered a formation or not is largely a matter of personal opinion. Certainly in the vicinity of San Pedro these beds are lithologically distinct from the underlying calcareous beds and from the overlying Lower San Pedro sands.

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[13] TIEJE, A. J., "The Pliocene and Pleistocene History of the Baldwin Hills, Los Angeles, California. A. A. P. G. Bull., Vol. 10, No. 5, p. 506. 1926.

CONCLUSIONS

The essential conclusions arrived at in this study are:

1. Two slightly different faunas are found in the silts exposed at Timms Point: a typical cool-water fauna above and a somewhat warmer-water transitional fauna below.

2. Reworking of fossils from beds exposed at Second Street and not indigenous to Timms Point indicates that the section at the latter locality overlies everything except the cool-water zone of sands above the calcareous beds at Second Street.

3. The small percentage of extinct species, the presence of a cool-water fauna attributable to a glacial stage, and the very modern aspect of faunas underlying that section in the vicinity of San Pedro indicate that these beds are best considered Pleistocene instead of Pliocene.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VII, No. 5, pp. 43-46 DECEMBER 19, 1931

A NEW SPECIES AND A NEW SUBSPECIES OF POCKET GOPHER

BY

LAURENCE M. HUEY

Curator of Birds and Mammals, San Diego Society of Natural History

In a collection of mammals from southern Inyo County, California, secured by representatives of the San Diego Society of Natural History during the spring and summer of 1931, are six specimens of pocket gophers from the Argus Mountains. Comparison with gophers taken at the type localities in the surrounding territory revealed diverging characters in the Argus Mountains specimens sufficient to warrant their being recorded as a new species.

Included in this paper is also the description of a new race of pocket gopher from Lower California, Mexico.

The writer is indebted to Mr. Donald R. Dickey and Dr. W. H. Burt of the California Institute of Technology, and to Dr. Joseph Grinnell and Dr. E. Raymond Hall of the Museum of Vertebrate Zoology for the loan of comparative material.

Thomomys argusensis sp. nov.

ARGUS MOUNTAINS POCKET GOPHER

Type.—From Junction Ranch, Argus Mountains, Inyo County, California; no. 9545, collection of the San Diego Society of Natural History; adult male; collected by Samuel G. Harter, August 10, 1931; original no. 133.

Characters.—A small eared, darkish colored (for desert region), small gopher; with relatively light boned skull having rounded or elliptically spreading

zygomatic arches; rostrum slender with medium length nasals; bullae small. Sexes show some difference in size, though not extreme.

Measurements.—See table, page 46.

Range.—Known from the following localities: Junction Ranch, Orando (=Arando) Mine, and Mountain Spring—all within the Argus Range of mountains.

Comparisons.—In color, *argusensis* is not unlike *Thomomys perpallidus perpes* from Lone Pine, Inyo County; but cranially it is very dissimilar to *perpes* and bears closer resemblance to the other mountain species of gophers, *scapterus* and *providentialis,* with which it evidently bears a close relationship.

Compared with *Thomomys scapterus* of the Panamint Mountains, *argusensis* differs in having longer rostrum; smaller bullae; more projecting incisors; shorter premaxillary tongues; and in having the posterior portion of the nasals sharply reduced in width by a distinct angle. In external color, *argusensis* is darker than *scapterus.*

Compared with *Thomomys providentialis, argusensis* is larger and darker. Cranially, *argusensis* has smaller, less globular bullae; smaller molars; more slender rostrum; more projecting incisors; longer premaxillary tongues. The nasals are longer and have the angle of reduction referred to above. The angle and spread of the zygomatic arches are not dissimilar, though in *argusensis* they are inclined to be more curved or rounded outwardly.

Remarks.—Grinnell[1] in his recent paper favors the possibility of a mountain stock as the ancestry of his newly named *Thomomys providentialis.* The characters of the species *argusensis,* here named, support the same view and lead the writer to regard the three mountain species, *scapterus, providentialis* and *argusensis,* as lying taxonomically outside the *perpallidus* group. The lack of square-spreading zygomatic arches and the light construction of the cranium offer evidence for this opinion.

Specimens examined.—*Thomomys perpallidus perpes*: Inyo County, California, 21 (16 from Lone Pine [type locality]; 5 from Olancha). *Thomomys perpallidus mohavensis*: San Bernardino County, California, 19 (8 from Victorville [type locality]; 11 from Hesperia). *Thomomys providentialis*: San Bernardino County, California, 5 (3 from Purdy, near Providence Mountains [type locality]; 2 from Leastalk, near Providence Mountains). *Thomomys scapterus*: Inyo County, California, 5 (Hanaupah Canyon, Panamint Mountains). *Thomomys argusensis*: Inyo County, California, 6 (4 from Junction Ranch [type locality]; 1 from Mountain Spring; 1 from Arando Mine).

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[1] Univ. of Calif. Publ. in Zool., Vol. 38, No. 1, pp. 1-10, Oct. 17, 1931.

Thomomys bottae catavinensis subsp. nov.

CATAVINA POCKET GOPHER

Type.—From Cataviña, Lower California, Mexico, lat 29° 54′ north, long. 114° 57′ west; no. 8256, collection of the San Diego Society of Natural History; adult female; collected by Laurence M. Huey, October 10, 1930.

Characters.—In size, *catavinensis* is like *Thomomys bottae cactophilus,* which it most nearly resembles, but in color is grayer with an ashy cast, rather than the buffy ochraceous of *cactophilus.* Compared with *Thomomys bottae abbotti* this form is smaller in size and grayer. In fact the most conspicuous character of *catavinensis* is color difference.

Cranially, *catavinensis* differs from *cactophilus* in a more rounded brain case, posteriorly. This slight character is constant throughout the series examined. Compared with *abbotti*, the skull of *catavinensis* is lighter in structure and smaller in size, but the two are nearly alike in the rounded brain case.

Range.—Known only from the vicinity of the type locality, Cataviña, Lower California, Mexico.

Specimens examined (all from Lower California, Mexico).—*Thomomys bottae abbotti*: 16 from one mile east of El Rosario (type locality); 2 from San Fernando. *Thomomys bottae catavinensis*: 12 from Cataviña (type locality). *Thomomys bottae cactophilus*: 17 from Punta Prieta (type locality); 2 from Santa Rosalia Bay. *Thomomys bottae russeolus*: 2 from Mesquital; 4 from Calmallí; 19 from Campo Los Angeles.

MEASUREMENTS OF *Thomomys argusensis*

S.D. S.N.H. No.	Sex	Locality Argus Mts., Inyo Co., California	Date 1931	Total length	Tail	Hind foot	Ear	Basilar length of Hensel	Nasals	Zygomatic breadth	Width of rostrum at middle	Interorbital constriction	Alveolar length of upper molar series
9356	♂	Arando Mine.....	May 7	194	56	27	4	32.2	11.9	21.0	7.1	6.2	8.0
9471	♀ *	Mountain Spring...	June 2	179	61	26	4	30.5	10.7	20.0	7.2	6.4	7.8
9545	♂ †	Junction Ranch.....	August 10	202	67	25	4	34.0	12.9	22.8	6.8	6.1	8.3
9652	♀	Junction Ranch.....	August 12	201	62	28	4	33.0	11.3	22.2	7.2	6.2	8.3
9653	♂	Junction Ranch.....	August 12	203	66	27	4	34.5	12.7	22.5	6.8	6.2	8.0
9654	♀ *	Junction Ranch.....	August 13	186	60	27	4	31.7	10.0	21.0	6.3	6.3	7.9

* Not fully adult.
† Type

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VII, No. 6. pp. 47-50 December 19, 1931

A NEW MEADOW MOUSE FROM LOWER CALIFORNIA, MEXICO

BY

Laurence M. Huey

Curator of Birds and Mammals, San Diego Society of Natural History

While comparing accumulated specimens of *Microtus californicus* from several localities in northern Lower California, Mexico, contained in the collection of the San Diego Society of Natural History, prior to writing names on the labels, the writer was impressed with the variation which exists between specimens from the region on the western base of the Sierra Juárez and those from the coast in the neighborhood of San Quintín and from the Sierra San Pedro Mártir.

Further comparison of the specimens from the Sierra Juárez region with meadow mice taken in the San Diegan area of southern California also revealed differences.

While the characters of the Sierra Juárez individuals are intermediate between those of the specimens from the other regions mentioned, they were found to be definite and constant. The following new name is therefore proposed.

Microtus californicus grinnelli[1] subsp. nov.

Sangre de Cristo Meadow Mouse

Type.—From Sangre de Cristo in Valle San Rafael on the western base of the Sierra Juárez, Lower California, Mexico, lat. 31° 52′ north, long. 116° 06′ west; no. 6165, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, June 26, 1927.

Characters and comparisons.—Compared with *Microtus californicus huperu-*

[1] Named in honor of Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California, in recognition of his outstanding work in California mammals.

thrus, grinnelli is reddish instead of grayish in color, and averages smaller in size. Cranially, *grinnelli* is smaller with slightly more globular audital bullae and with the spread of the zygomatic arches averaging less.

Compared with *Microtus californicus aequivocatus*, *grinnelli* is slightly lighter in dorsal reddish color and averages much smaller in size. Cranially, the audital bullae are slightly more globular, and the zygomatic arches are less widely spreading and are not as heavily boned.

Compared with *Microtus californicus sanctidiegi*, *grinnelli* is brighter in reddish color, and averages larger in size. Cranially, the incisive foramen is much larger, the audital bullae are slightly larger, and the zygomatic arches are more wide spreading.

Range.—So far as known, the region immediately west of the Sierra Juárez, Lower California, Mexico.

Measurements.—In the table below certain measurements have been used that were quoted by Kellogg in his paper "A Revision of the *Microtus californicus* Group of Meadow Mice,"[2] taken from specimens in the Field Museum; and certain of those quoted by Grinnell in his paper "Critical Examination of the Meadow Mice of Lower California,"[3] taken from specimens in the Museum of Vertebrate Zoology. These measurements, designated in the foot-notes, were used by the writer to increase his mensural comparison of adult *M. c. huperuthrus* from the Sierra San Pedro Mártir.

AVERAGE MEASUREMENTS IN MILLIMETERS

	No. of Specimens	Length	Tail	Hind foot	Ear	Condylo-basal length	Basilar length of Hensel	Nasal length	Zygomatic width	Interorbital constriction	Height of cranium at bullae	Upper molar series
MALES												
M. c. aequivocatus	5[4]	206.2	58.6	24.8	11.6	31.7	27.9	9.9	18.4	3.8	11.4	7.3
M. c. huperuthrus	3[5]	199.3	53.6	24.6	11.5	31.9	28.2	10.4	17.9	3.8	11.5	7.7
M. c. grinnelli	4	187.7	51.0	24.0	12.2	29.7	26.0	9.2	17.0	3.4	11.0	6.7
M. c. sanctidiegi	5	175.6	53.4	23.4	11.4	29.0	25.5	8.8	16.5	3.7	10.9	7.0
FEMALES												
M. c. aequivocatus	4	206.5	56.5	25.5	12.2	32.1	28.1	10.0	18.9	3.7	11.4	7.8
M. c. huperuthrus	9[6]	187.7	52.0	24.0	12.0	29.9	26.3	9.2	17.0	3.5	10.8	7.5
M. c. grinnelli	4	180.2	51.4	24.0	12.2	29.4	25.6	8.6	16.8	3.6	10.6	6.9
M. c. sanctidiegi	5	169.8	49.8	22.6	11.4	28.6	25.1	8.6	16.0	3.5	10.4	6.9

[2] KELLOGG, R. Univ. Calif. Pub. Zool., Vol. 21, pp. 1-42.
[3] GRINNELL, J. Journ. Mammalogy, Vol. 7, No. 3, pp. 221-226.
[4] One specimen, MVZ 35874, included.
[5] Two specimens, MVZ 35882 and FM 10740, included.
[6] Six specimens, FM 10735-10739 and 10741, included.

Remarks.—The presence of a coastal and a mountain form of meadow mouse in northern Lower California has been well established systematically and nomenclaturally both by Grinnell[7] and by Osgood,[8] but, probably through the lack of specimens from a more northerly locality, the third form here named was not discovered.

In the Lower California forms *aequivocatus, huperuthrus* and *grinnelli*, the large sized incisive foramen is the only character which is alike in all three and which, incidentally, provides an outstanding difference between the three above mentioned forms and the southern California form *sanctidiegi*, whose incisive foramen is much smaller.

Specimens examined.[9]—*Microtus californicus huperuthrus*: Lower California, Mexico, 9 (La Grulla, Sierra San Pedro Mártir [type locality]). *Microtus californicus aequivocatus*: Lower California, Mexico, 22 (1 from San José, 5 from Las Cabras, 16 from 1 mile east of El Rosario). *Microtus californicus grinnelli*: Lower California, Mexico, 10 (8 from Sangre de Cristo [type locality], 2[10] from La Grulla near Ensenada). *Microtus californicus sanctidiegi*: San Diego County, California, 27 (12 from Escondido [type locality], 4 from Adobe Falls, near La Mesa, 11 from Murray Dam, near La Mesa).

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[7] GRINNELL, J. Op. cit.

[8] OSGOOD, W. H. Journ. Mammalogy, Vol. 9, No. 1, pp. 52-56.

[9] Specimens actually at hand, and not measurements taken from publications.

[10] Not typical.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VII, No. 7, pp. 51-52 April 15, 1932

A NEW WHITE-FOOTED MOUSE FROM LOWER CALIFORNIA, MEXICO

BY

E. W. Nelson and E. A. Goldman

U. S. Bureau of Biological Survey

Among mammals recently acquired by the San Diego Society of Natural History are five specimens of white-footed mice of the widely ranging *Peromyscus maniculatus* group, from a small island in Gonzaga Bay, Lower California. These were believed to be of especial interest by Mr. Laurence M. Huey, Curator of Birds and Mammals, who has generously forwarded them for our use in connection with general studies of the mammals of that region. The specimens are assigned to a new subspecies here described.

Peromyscus maniculatus hueyi subsp. nov.

Gonzaga Bay White-footed Mouse

Type.—From a small unnamed island in Gonzaga Bay, east coast of Lower California, Mexico (latitude about 29° 50′). No. 8861, ♂ adult, collection San Diego Society of Natural History, collected by A. W. Anthony, November 21, 1930. Original number 1172.

Distribution.—Known only from the type locality.

General characters.—A very dark subspecies, most closely allied to *Peromyscus maniculatus coolidgei* of southern Lower California and the adjacent mainland, but contrasting strongly in darker color; skull differing in slight details. Also nearly related to *P. m. sonoriensis*, but much darker with skull somewhat lighter

in structure. Similar in color to dark phase of *P. m. gambeli,* but upper parts suffused with gray instead of brownish as usual in that form, and cranial characters distinctive.

Color.—Type (fresh pelage): Upper parts in general buffy grayish heavily mixed with black, the black predominating over dorsum; cheeks, shoulders, and sides lighter owing to thinning of dark hairs; under parts white, pure white to roots of hairs on lips and chin, the basal color plumbeous across abdomen; outer sides of forearms and hind legs buffy grayish or brownish, becoming abruptly white on feet; ears clothed with short black hairs, the margins narrowly but distinctly edged with white; tail sharply bicolor, black above, white below.

Skull.—Closely resembling that of *P. m. coolidgei,* but rather flat, the zygomata slender, and usually less squarely spreading anteriorly; premaxillae usually more attenuate, less deeply interdigitating with frontals; rostrum moderately heavy as in *coolidgei.* Similar to that of *P. m. sonoriensis* but somewhat lighter in structure. Compared with that of *P. m. gambeli* the skull is slightly larger with heavier rostrum.

Measurements.—Type: Total length, 168 mm.; tail vertebrae, 75; hind foot, 20. Average of four adult topotypes: 165 (160-170); 76 (68-83); 21 (20-21). Skull (type): Greatest length, 25.3; condylobasal length, 23.3; zygomatic breadth, 12.8; interorbital constriction, 4.2; interparietal, 9.2 x 2; length of nasals, 9.5; maxillary toothrow (alveoli), 4.2.

Remarks.—Forms of *Peromyscus maniculatus* are generally distributed on the islands along the Pacific coast of Lower California, but have not hitherto been found on the islands off the east coast in the Gulf of California. In view of the fact that most small mammals from the arid desert regions of the northeastern part of the Peninsula are very pale, in keeping with the tone of their usual environment, the dark color of *P. m. hueyi* is surprising. The type was taken on the same day as the type of the canyon mouse, *Peromyscus crinitus pallidissimus,* recently described by Huey from the same island,[1] as characterized by extreme pallor. The new form is not very unlike some of the darker examples of *P. m. clementis* and *P. m. catalinae* in external appearance, but the skulls indicate no close relationship. Specimens of *P. m. sonoriensis* from San Felipe, on the mainland north of Gonzaga Bay are darker than usual in that form and suggest possible gradation toward *hueyi.*

Specimens examined.—Five, from the type locality.

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[1] Trans. San Diego Soc. Nat. Hist., Vol. VI, No. 26, pp. 389-390, Aug. 28, 1931.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 8, pp. 53-84, plates 2-4, text figs. 1-4

THE EOCENE SIERRA BLANCA LIMESTONE AT THE TYPE LOCALITY IN SANTA BARBARA COUNTY, CALIFORNIA

BY

MARVIN FRANCIS KEENAN

Leland Stanford Junior University

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

APRIL 15, 1932

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Palaeozoic Crustacea.

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TRANSACTIONS

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THE EOCENE SIERRA BLANCA LIMESTONE AT THE TYPE LOCALITY IN SANTA BARBARA COUNTY, CALIFORNIA

BY

MARVIN FRANCIS KEENAN

Leland Stanford Junior University

SAN DIEGO, CALIFORNIA

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[1] Before the completion of this paper, the author was killed in an automobile accident, on December 25, 1931. Most of the text was written and many of the illustrations were ready for publication, but some sections were in the form of notes. The section on systematic paleontology cannot be published, as that part of his work was not completed. I have gone over the manuscript, notes, maps, thin-sections, and illustrations with some of the author's associates, especially Messrs. George L. Richards, Jr., Harry E. Wheeler, P. W. Reinhart, and J. H. McMasters, and herewith present the paper in its original form, as far as possible.

HUBERT G. SCHENCK

Fig. 1. Sketch map showing the type locality of the Sierra Blanca limestone and some of its correlatives.

INTRODUCTION

The purposes of this paper are to describe one of the few pure, massive limestones known in the Teritary System of the west coast of North America, to show that at its type locality this limestone—the Sierra Blanca—rests upon a Cretaceous formation, and by correlations with other formations to prove that the Sierra Blanca limestone is older than the Tejon (restricted) stage of the Eocene, thereby confirming the opinion of R. N. Nelson, who named the formation. Moreover, the rock is interesting paleontologically because it carries abundant orbitoidal and nummulitoid foraminifers and calcareous algae. Limestones having a similar fossil content are known in other parts of Santa Barbara County, as shown on the map, Figure 1. Reasons are presented for believing that the orbitoid-bearing strata exposed at each of these localities were deposited during middle Eocene time.

ACKNOWLEDGMENTS

The project leading to the publication of this paper was carried on at Stanford University under the direction of Professor Hubert G. Schenck, to whom I am indebted for assistance in field and laboratory. I am also grateful to Dr. R. N. Nelson for suggestions and for numerous thin sections of Eocene limestones from Santa Barbara County. Mr. Nash-Boulden, Mr. Glenn White, and others of the United States Forest Service cooperated in a most hearty manner. It also gives me pleasure to record herein the discovery of Mr. Leslie Whipple, formerly of the University of California, of orbitoidal limestone on the south side of Mount Diablo, Contra Costa County. His thin sections and other data were kindly placed at my disposal by Professor Bruce L. Clark. To my cousins, especially Clarence R. and Albert C. Mattei, I am indebted for the opportunity to begin and continue the investigation. The field assistance of Messrs. Homer E. Widmann, Harry E. Wheeler, L. M. Clark, L. B. Snedden, and Clifford M. Coffman is gratefully acknowledged. There are many others who have offered valuable suggestions and otherwise assisted in the prosecution of the work, and I wish to acknowledge their kindnesses.

Previous Work

1856. Antisell, Thomas, U. S. Pac. R. R. Repts., Vol. 7, pt. 2, pp. 65-74; p. 200, pl. III.

Notes on the topography, structure, and lithology of the "Santa Barbara Mountains." He gives two fossil lists (p. 73), one from the north side of the Santa Ynez Mountains (in the Santa Ynez Valley), and the other from the south side of the Santa Ynez Mountains, in the Gaviota Pass. Antisell thought it probable that the strata of the San Rafael Mountains were similar to those of the Santa Ynez.

1894. Fairbanks, H. W., Geology of Northern Ventura, Santa Barbara, San Benito, San Luis Obispo, and Monterey Counties; Twelfth Ann. Rept. Calif. State Min. Bur., pp. 493-526, 17 text figures.

Discusses stratigraphy of area between the San Rafael and Santa Ynez Mountains (pp. 498-506). Fairbanks says (p. 498), "The Santa Ynez (Range) is formed, as far as is known, of Miocene rocks exclusively."

1918. Hawley, Henry J., Geology and Paleontology of a Portion of the Santa Ynez Range, California; Thesis for the M. A. degree, Stanford University, Calif.

This manuscript describes in particular the Cretaceous fossils and stratigraphy of the Gaviota Pass region, as well as the overlying Eocene rocks. The youngest Eocene beds with *Turritella lompocensis* Arnold (equals *T. variata* Conrad) he designated "upper Tejon."

1919. Kew, William S. W., Geology of a Part of the Santa Ynez River District, Santa Barbara County, California; Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 12, No. 1, pp. 1-21, 2 pls., 2 text figures.

This paper mentions a limestone bed ". . . traced from east of Blue Canyon to Oso Creek." The same limestone occurs in the syncline which lies immediately north of the Santa Ynez River in the vicinity of Mono Creek. A faunal list from a locality immediately east of Oso Creek furnishes evidence upon which to propose a Miocene age for this limestone. (This has, however, proven to be an Eocene rock).

1923. Israelsky, Merle C., Note on the Fossil Content of the San Rafael Limestone of the San Rafael Mountains, Santa Barbara County, California; Science, n. s., Vol. 58, No. 1505 (Title only).

1923. Israelsky, Merle C., Some New Forms of West Coast Fossil Echinoidea; Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 14, No. 11, pp. 377-396, pls. 69-74, 1923.

Gives descriptions of several new fossil echinoids. Two new Eocene species, *Linthia sanrafaelensis* and *Amblypygus subhemisphericus* are the first of their respective genera to be reported from

California. These specimens were collected by R. N. Nelson from a limestone in the San Rafael Mountains, Santa Barbara County, California, where they were associated with *Campanile,* sp.

1925. NELSON, RICHARD N., Geology of the Hydrographic Basin of the Upper Santa Ynez River, California; Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 15, No. 10, pp. 327-396, 1925.

Of particular interest here is the discussion of the "Eocene Series of Upper Mono Creek." Of this series Nelson writes (p. 350): "A great thickness of strata which includes a limestone member, largely built up of Eocene genera of orbitoid foraminifera, overlies the undifferentiated Cretaceous in the northeastern part of the district. With the exception of the foraminifera and a few indeterminate species of oysters, no other fossils have been found in this group. No orbitoid foraminifera have been described from any of the Eocene horizons of California so they are, as yet, of no value in local correlation. Because of this absence of a definite means of correlation, the post-Cretaceous strata of upper Mono Creek have been separated into lithologic subdivisions which have been given local names. From the bottom upwards these are: Indian conglomerate, Mono shale, Sierra Blanca limestone, and undifferentiated Eocene."

1928. CARTWRIGHT, LON D., Sedimentation of the Pico Formation; Bull. Amer. Assoc. Pet. Geol., Vol. 12, No. 3, pp. 235-269, March, 1928.

Notes the occurrence of *Lithothamnium* limestone pebbles in the conglomerate of the Lower Pico (Pliocene) beds (p. 257). Associated with the alga *Lithothamnium* are numerous fossil fragments of pelecypods and some of the smaller foraminifera. These pebbles were probably derived immediately from Sespe conglomerates and ultimately from Meganos strata.

"The discovery of Lithothamnium limestone in California was made by H. G. Schenck during a reexamination of organic limestone described by R. N. Nelson (Univ. of Calif. Dept. of Geol. Bull., Vol. 15, No. 10 (1925, p. 352), who mapped its occurrence in the upper Santa Ynez River basin and considered it of Meganos (Eocene) age. The discovery was announced in a joint paper by H. G. Schenck and R. N. Nelson, presented before the Le Conte Geological Club, Mar. 6, 1926."

1928. NELSON, R. N. and SCHENCK, H. G., Calcareous Algae in Pacific Coast Limestones; Bull. Geol. Soc. Amer., Vol. 39, p. 266, March, 1928 (Abstract).

Notes of recognition of *Lithothamnium* in Eocene limestones of the Santa Ynez Mountains.

1928. KERR, PAUL F., and Schenck, Hubert G., Significance of the Matilija Overturn; Bull. Geol. Soc. Amer., Vol. 39, pp. 1087-1102, 4 figures.

The Tejon formation is divided into three members; Matilija

sandstone (lowermost), Cozy Dell shale (middle), and Coldwater sandstone (uppermost Eocene), overlain by the Sespe formation.

(Subsequent work shows that the Matilija sandstone rests on Domengine shale and also that the three members of the Tejon can be traced to the western Santa Ynez Range and are stratigraphically above orbitoid-bearing limestones).

1929. Schenck, Hubert G., Discocyclina in California; Trans. San Diego Soc. Nat. Hist., Vol. V, No. 14, pp. 211-240, pls. 27-30, figs. 1-10, Feb. 27, 1929.

Discusses the occurrence of *Discocyclina* in California and describes several species of this genus, including one new species. He recognizes, for the first time, stellate orbitoids in western North America. *Discocyclina* from the Sierra Blanca limestone is of particular interest. Associated fossils (p. 221) include *Archaeolithothamnium*, *Lithophyllum*, bryozoans, mollusks, *Globigerina* and others of the smaller Foraminifera.

First recognition of *Archaeolithothamnium* in the Eocene rocks of western North America.

1930. Nelson, R. N. and Schenck, H. G., Eocene Algae and Stellate Orbitoids from the Santa Ynez Range, California; Pan American Geologist, Vol. LIV, No. 3, Oct. 1930, p. 240 (Summary statement).

Correlation of limestone in Jalama Creek with Sierra Blanca limestone.

Ibid; Bull. Geol. Soc. Amer., Vol. 42, No. 1, p. 371, March, 1931, (Abstract).

1930. Woodring, W. P., Upper Eocene Orbitoid Foraminifera from the Western Santa Ynez Range, California, and their Stratigraphic Significance; Trans. San Diego Soc. Nat. Hist., Vol. VI, No. 4, pp. 145-170, pl. 13-17, July 12, 1930.

Describes a new species of *Discocyclina* and a new species of *Actinocyclina* collected from a limestone lense in a shale series located in Cañada de los Sauces, about two miles southwest of Sudden, Guadalupe Quadrangle, Santa Barbara County, California. The stratigraphic sequence at this locality is given. The limestone carries calcareous algae, foraminifers, echinoid spines, and a few mollusks. This series of beds is overlain disconformably by Vaqueros conglomerate and sandstone carrying "*Pecten*" *magnolia* and *Turritella inezana.*

A collection was made in Jalama Creek, about 10 miles southeast of Cañada de los Sauces, on the north slope of western Santa Ynez Range. Figures of rock sections cut at random are given. These show sections of *Actinocyclina aster* Woodring and *Discocyclina psila* Woodring.

The beds carrying the orbitoid-bearing limestones are correlated

with the *Turritella variata* beds in the region of Gaviota Pass which he shows lie at the top of the Tejon section and carry a peculiar Pacific fauna characterized by *Turritella variata, "Crassatellites" collina, Venericardia hornii,* and others.

1931. CLARK, L. M., Additional Notes on the Stratigraphy of the Santa Ynez Mountains; Bull. Amer. Assoc. Pet. Geol., Vol. 15, Jan. 1931 (Title only).

At the meeting of the above mentioned association, Clark presented evidence to show that the *Turritella variata* zone (disputed Oligocene-Eocene fauna) is stratigraphically younger (more than 3300 feet above) the orbitoid-bearing limestones found in the region of Jalama Creek and in the region of Nojoqui Creek (about 2 miles east of Hill 1921).

The speaker believed that the *Turritella variata* zone of the western Santa Ynez is the same as the Coldwater sandstone of the eastern Santa Ynez Range. This paper is referred to by Woodring in his 1931 paper.

1931. WOODRING, W. P., Upper Eocene Orbitoidal Foraminifera from the Santa Ynez Range, California; Bull. Geol. Soc. Amer., Vol. 42, No. 1, Mar. 1931, p. 370 (An abstract of the author's 1930 paper, see above).

1931. WOODRING, W. P., Age of the Orbitoid-bearing Eocene Limestone and *Turritella variata* zone of the Western Santa Ynez Range, California; Trans. San Diego Soc. Nat. Hist., Vol. VI, No. 25, pp. 371-388, 1931.

The author points out that his correlation of the orbitoid-bearing limestone beds (carrying stellate *"Orthophragmina"*) with the *Turritella variata* zone, of the Gaviota region in Santa Barbara County, is erroneous. He considers the discoidal *"Orthophragmina"* to be a more reliable indicator of age than the stellate form, and again states his belief that *Discocyclina psila* Woodring is closely allied to *D. purpusilla* Vaughan, a Mexican species from beds referred to middle Eocene.

SUBJACENT FORMATIONS

The strata that underlie the Sierra Blanca limestone were separated into lithologic units and given local names by R. N. Nelson.[2] In ascending order, these are: Undifferentiated Cretaceous, Indian conglomerate, and Mono shale. These beds dip to the northeast at angles varying from 25° to 60° (Fig. 2).

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[2] NELSON, R. N., Geology of the Hydrographic Basin of the Upper Santa Ynez River, California; Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 15, No. 10, pp. 327-396, pl. 45-48, 1925; p. 343, pp. 350-352.

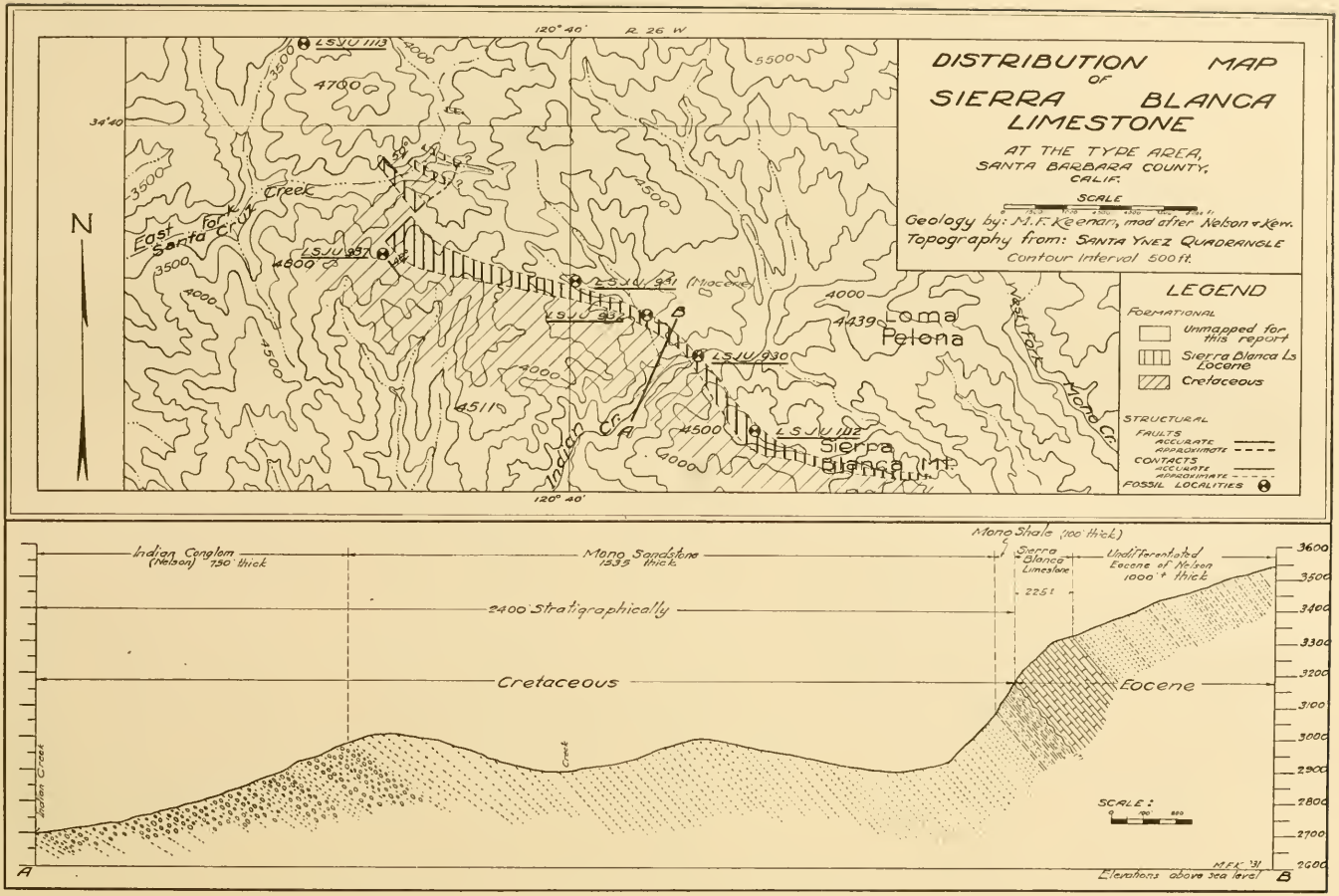

Fig. 2. Map showing areal distribution and field relations of the Sierra Blanca limestone at the type area. Fossil localities indicated by crosses.

Undifferentiated Cretaceous. Nelson's Undifferentiated Cretaceous series is made up of 7700 feet of arkosic sandstone beds, in places alternating with beds of shale. The upper part of this series is composed of arkosic sandstones which are sharply separated from the overlying Indian conglomerate beds, but with no apparent discordance in dip.

Several specimens of *Opis triangulata* (Cooper) were reported by Nelson from a locality in Indian Canyon.[3] Nelson points out that this is the same species that occurs in the Chico formation in the Santa Ana Mountains of southern California, and that the presence of this species together with *Inoceramus,* found in Mono Creek, shows that most of the upper part of the Undifferentiated Cretaceous belongs to the Chico formation.

Indian conglomerate. The Indian conglomerate is well described by Nelson.[4] It is best developed in Indian Canyon, where its thickness of about 750 feet was measured by the writer. It thins and lenses out along its strike both east and west from this locality. Nelson traced the Indian conglomerate as far east as Mono Creek. No beds of cemented conglomerate, of the character of those found in Indian Canyon, were found to be present between the headwaters of Buckhorn Creek (3 miles west of Indian Canyon) and the East Fork of Santa Cruz Creek. However, a band of loose boulders, gravel, and sand outcrops along the top of the ridge at the head of Buckhorn Creek. This band is about one-eighth of a mile wide, and extends for about a mile in a general east-west direction. The boulders are similar in composition to those found in the Indian conglomerate and this outcrop may represent the uncemented or weathered equivalent of the latter.

The Indian conglomerate is sharply separated from, but appears to be conformable with, the underlying Chico sandstones. It grades upward into a massive, buff, arkosic sandstone, which, in turn, grades into a gray, sandy shale. The contact between the Indian conglomerate and the overlying Mono "shale" is drawn at the top of the conglomerate beds. Nelson considered the Indian conglomerate and the Mono shale to be a part of a conformable series which includes the Sierra Blanca limestone. Assuming the Eocene age of the limestone by the presence of *"Orthophragmina,"* he placed the base of the Indian conglomerate as the lower limit of the Eocene series of this region.

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[3] NELSON, R. N., Op. cit., p. 346.

[4] NELSON, R. N., Op. cit., p. 350.

Mono shale. The Mono shale is best developed in Mono Canyon, from which locality it was described by Nelson.[5] For a distance of about 3 miles to the west of Mono Creek, the Mono shale is constant in character, but one-half of a mile to the east of Indian Creek the shale beds grade both laterally and stratigraphically into massive sandstone beds. The character of the Mono "shale" on the west side of Indian Creek is illustrated in Plate 2, figure 2. The total thickness of the Mono shale in Indian Creek is 1650 feet. Here, the top 120 feet are made up of gray shale and fine-grained gray sandstone, while the basal 1530 feet are massive, coarse-grained sandstones. The gray-shale facies of this member (Fig. 2) immediately underlies the Sierra Blanca limestone, in varying thicknesses, for the entire distance that the latter formation is exposed.

Two specimens of ammonites, two specimens of *Inoceramus* sp. indet., an *Acila* (*Truncacila*) sp., and numerous fragmentary *Inoceramus* prisms were discovered in the Mono shale less than 100 feet stratigraphically below the base of the Sierra Blanca limestone. These fossils were found in dark-colored, calcareous concretions in the gray-shale facies in the upper part of the Mono shale member at L.S.J.U. Locality 937.[6] One of the ammonites was too poorly preserved for generic identification. The other, however, was determined by Dr. Frank M. Anderson[7] as *Desmoceras*, similar to an undescribed species of *Desmoceras* from the lower Chico.

This paleontologic evidence, therefore, points to the Cretaceous (Chico) age of the Indian conglomerate and Mono shale, formations heretofore considered to be Eocene in age.

The Sierra Blanca Limestone

The Sierra Blanca limestone[8] was named, described, and partially

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[5] Nelson, R. N., Op. cit., p. 352.

[6] A description of this locality will be found in the Register of Fossil Localities, p. 78.

[7] Honorary Curator, Department of Paleontology, California Academy of Science, San Francisco, California.

[8] Wilmarth, Grace M., Names and Definitions of the Geologic Units of California; U. S. Geol. Survey Bull. 826, p. 81, 1931.

The Chairman, Committee on Geologic Names of the United States Geological Survey, informed Hubert G. Schenck, by letter dated October 27, 1930, that

"In 1920 (Am. Jour. Sci., 4th ser., Vol. 50, p. 417) D. R. Semmes loosely applies the term *Sierra Blanca series* to the Upper Cretaceous and Eocene (?) rocks of the Sierra Blanca Basin, New Mexico. As these rocks are divisible into several formations, it seems unlikely that Semmes's name will ever be used again, and this Survey would not consider it a barrier to the use of *Sierra Blanca limestone* for the Eocene formation of Santa Barbara County, California, to which it has been applied by Nelson."

mapped by R. N. Nelson.[9] This formation is located on the south side of the San Rafael Mountains, in the southeasterly portion of the Santa Ynez Quadrangle, Santa Barbara County, California. Here it outcrops as a massive, grayish-white, highly fossiliferous, evenly bedded limestone which dips normally to the northeast at angles varying from 50 to 60 degrees. Natives of the Santa Ynez Valley and vicinity refer to this formation as the "White Ledge." It is conspicuously exposed on the south side of Sierra Blanca Mountain (Plate 2, figure 1), which is one and one-half miles southwest of Loma Pelona as shown on the U. S. Geological Survey topographic map.

At its most easterly exposure, the limestone pinches out between shale beds, as pointed out by Nelson. From this point its outcrop is continuous for a distance of about 7 miles to the northwest, to a point in the east fork of Santa Cruz Creek, where it is cut off by faulting. Nelson tentatively mapped approximately 2 miles of this formation west of Indian Creek. This portion was re-mapped by the writer and the most westerly portion was mapped for the first time.

A water-gap through the limestone at Indian Creek exposes a thickness of 225 feet of this formation and affords an excellent locality for collecting samples. This locality, therefore, is taken as the type locality of the Sierra Blanca limestone (L.S.J.U. loc. 930), and the section as measured here is presented in Figure 2, page 62.

The upper 65 feet of the Sierra Blanca limestone at its type locality consists of dark gray, granular, evenly bedded strata varying in thickness from 6 inches to 2 feet. Sandy, buff-colored beds up to a foot thick occur near the top and appear to grade into the overlying series of sandstones and shales (Nelson's Undifferentiated Eocene).[10] Grains of glauconite and of limonite are found disseminated throughout this upper portion of the limestone. Fossils are very abundant. The recognizable larger fossils include plates and ambulacra of echinoderms, small brachiopods similar to the genus *Terebratalia,* oyster shell fragments, and a single specimen of a shark's tooth (*Isurus?*). The tests of fossil micro-organisms make up the greater part of the calcium carbonate in the rock. They include *Discocyclina psila* Woodring, *Robulus* sp. indet., *Globigerina* sp., *Nodosaria* sp., a bi-serial foraminifer and also a coiled form which is taken to be a nummulitoid foraminifer, bryozoans, and some calcareous algae.

9 NELSON, R. N., Op. cit., pp. 352-354.

10 NELSON, R. N., Op. cit., p. 354.

The remaining 160 feet are composed of dense, fine-grained buff to white-colored, almost pure limestone characterized by its high content of calcareous algae. There are occasional beds of terrigenous limestone and variations in the fossil content. With one or two exceptions, the beds grade into one another stratigraphically.

The paleontologic characteristics of the limestone as a whole may be summarized as follows:

(Top of Section)

Division A.	0-60 feet:	*Discocyclina psila* Woodring predominates. Algae constitute a very minor part of the fossils present. Brachiopods, echinoderms, and oyster shell fragments are present in the upper portion.
Division B.	60-115 feet:	Algae, *Discocyclina psila* Woodring, and smaller Foraminifera in dense, fine-grained limestone.
Division C.	155-225 feet:	Algae predominate. No orbitoidal Foraminifera observed. Other characteristics of rock similar to that in Division B.

The following is a more detailed description of the lithologic and paleontologic characteristics of the Sierra Blanca limestone as shown from a study of the rock in random-cut thin sections and polished surfaces of samples taken from a section measured at the type locality (Fig. 2). The character of the rock is gradational stratigraphically and the description of the section which follows is, therefore, that of typical limestone samples taken from points an indicated number of feet below the top of the limestone.

Depth in feet below top of limestone

DIVISION A.

Top of limestone (overlain by and grading into Nelson's Undifferentiated Eocene[11]) 0

1. Beds of buff-colored, very sandy, fossiliferous limestone varying in thickness from 6 inches to 2 feet are found interbedded with beds of dark-gray, granular, fossiliferous limestone, of similar thicknesses, which weather to a light-gray, sandy surface. Rounded to angular grains of glauconite and limonite occur disseminated throughout the rock. Some of the smaller foraminiferal shells are filled with glauconite. Fossil content is characterized by brachiopods similar to the genus

[11] NELSON, R. N., Op. cit., p. 354.

Terebratalia, echinoid spines and plates, fragments of oyster shells, fragments of bryozoans, and many foraminifers. The most abundant fossil is *Discocyclina psila* Woodring, which in certain thin beds makes up the major part of the rock material. Other foraminifers observed include a coiled form similar to *Amphistegina* or *Operculina* sp., *Nodosaria*, a biserial form, *Globigerina*, *Robulus*, and *Nonion* (?)..... 10

2. Fine-grained, almost non-fossiliferous beds of brown-gray limestone containing grains of glauconite and limonite..... 13

3. Sandy, buff to cream colored, highly fossiliferous, glauconitic limestone. A specimen of an echinoid (*Linthia sanrafaelensis* Israelsky?) was found imbedded in the rock, parallel to the bedding plane and with the ambulacral side up, an indication that the beds are dipping normally..... 17

4. Gray-brown, fine-grained, sandy limestone containing glauconite in rounded to subangular grains. Fossil content characterized by numerous *Discocyclina psila*, fragments of macroscopic shells, foraminifers (*Nodosaria, Globigerina*), and occasional fragments of calcareous algae..... 25

5. Gray to gray-brown, granular, dense limestone which weathers light-gray in color. Some beds contain rounded siliceous pebbles up to 5 mm. in diameter. Small amounts of glauconite grains are found throughout. Fossils are not abundant; *Globigerina*, *Nonion* (?), and a biserial foraminifer are the genera making up the greater part of the fossils here..... 53

DIVISION B.

6. Buff to brown, even-grained, granular limestone characterized by a few *Discocyclina psila*. Other forms rare..... 62

7. Almost white, dense, very fine-grained limestone which weathers to a smooth, gray-colored surface. Algae are most abundant, but many *Discocyclina psila* are present, together with other Foraminifera including the coiled form similar to *Amphistegina* or *Operculina*. Lithology in marked contrast with the beds above this point in the section..... 65

8. Brown-gray, very dense, highly fossiliferous pure limestone characterized by numerous *Discocyclinas* and other Foraminifera 75

9. Coarse-grained, algal limestone with a few *Discocyclinas* 79

10. Fine-grained, dense, buff-colored limestone. Very pure. Matrix made up of yellowish mealy particles. Algae and Foraminifera present..... 87

11. A bed of terrigenous, friable, glauconitic, dark-gray limestone 1 foot thick occurs at this horizon. This bed is sharply differentiated from the massive, cream-gray pure limestone

beds above and below it. Fossil content characterized by fragments of algae, *Discocyclina* and other Foraminifera..... 88

12. Dense, fine-grained, buff-colored limestone. Matrix of yellowish to buff-colored, mealy material, with some feldspar grains. Weathers to buff-gray smooth surface. Algae predominate among the fossils, with Bryozoa abundant and *Discocyclina* and *Robulus* outstanding among the Foraminifera..... 98

13. Buff-gray, dense, fine-grained limestone. Fossil content characterized by numerous *Discocyclina* which make up the greater portion of the rock. Algae second in importance, followed by smaller Foraminifera, such as *Robulus* and *Globigerina* 107

14. Dense, buff-cream to gray limestone similar to last described portion of section with the exception of the fossil content. Here algae constitute practically all of the material of the rock. *Discocyclina* and other Foraminifera few..... 111

15. General lithologic character of rock similar to that just described. Algae constitute the greater part of the material of the limestone. No *Discocyclina* observed. *Robulus,* a biserial foraminifer, and fragments of Bryozoa occur here..... 114

DIVISION C.

16. Dense, pure, buff-cream, fine-grained limestone characterized by many algae, *Discocyclina* and other Foraminifera..... 127

17. Buff to gray, dense, fine-grained limestone. Occasional grains of glauconite and limonite found along with numerous *Discocyclina,* algae, Bryozoa, and smaller Foraminifera..... 135

18. Dense limestone of the character described above, containing numerous algae and few *Discocyclina*..... 155

19. Dense, fine-grained, buff-gray, pure limestone. Fossil content characterized by numerous algae. Specimens of *Discocyclina* appear to be lacking. Biserial foraminifers, *Robulus,* and others are present..... 175

20. At this level is a 4-foot bed of yellowish-buff, pure, dense, fine-grained limestone. Algae constitute the major portion of the rock. The matrix is fine-grained, yellowish, mealy material 183

21. Cream-gray, dense limestone which weathers to a smooth gray surface. Characterized by abundance of algae and by shell and bryozoan fragments, *Robulus, Amphistegina,* and a biserial foraminifer 192

22. Coarse-grained, white to buff-colored limestone. Most of rock made up of fragments of algae cemented by a fine-grained calcareous matrix. In places this cement is red in color..... 217

23. Dense, fine-grained, cream-gray limestone characterized by numerous branches of calcareous algae and Foraminifera. This is the lowermost bed of the Sierra Blanca limestone in this section 225

SUPERJACENT FORMATIONS

At the type locality of the Sierra Blanca limestone, the superjacent formations consist of a gradational series of conformable, evenly bedded, apparently unfossiliferous, alternating sandstones and shales which here attain a thickness of over 2,000 feet. Nelson[12] described this series of beds under his Undifferentiated Eocene. This series, in turn, is unconformably overlain by shales and limy sandstones carrying Miocene fossils. At all localities observed, shales predominated over the sandstones of this group. These Miocene beds in places immediately overlie the Sierra Blanca limestone itself with unconformable contact. This condition is best seen in the west branch of Indian Creek, about one mile west of the type locality of the limestone. At the former locality, numerous specimens of *Pecten lompocensis* Arnold were collected from a coarse, calcareous sandstone bed about four feet thick (L.S.J.U. loc. 931). Mr. William Corey, who kindly determined the species of the *Pecten,* considers it to be a marker for beds of Temblor (Miocene) age.

At its most westerly exposure, the Sierra Blanca limestone is overlain, unconformably as before, by a Foraminifera-bearing siliceous shale. The Foraminifera from this locality include the following forms:

Robulus n. sp. Kleinpell. Present
Bolivina marginata Cushman. Rare
Siphogenerina branneri (Bagg). Common
Siphogenerina hughesi Cushman. Rare
Siphogenerina reedi Cushman, n. var. Kleinpell. Rare
Siphogenerina kleinpelli Cushman. Present
Uvigerinella californica Cushman. Rare
Valvulineria n. sp. Kleinpell. Common
Baggina californica Cushman. Rare
Eponides sp. Present
Cassidulina aff. *crassa* d'Orbigny. Rare

Mr. Robert M. Kleinpell and Dr. Hubert G. Schenck were kind enough to check over this group of fossils and both agree that the stratigraphic position of the beds containing them is below the *Valvulineria californica* zone of the type Monterey formation and probably above, rather than below, the "Button Bed" of the Temblor formation at its type locality along Carneros Creek, in Kern County, California.

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12 NELSON, R. N., Op. cit., p. 354.

CHEMICAL ANALYSES

The following chemical analyses were made by Mr. Leslie Larrieu, of Los Angeles. The samples are from DIVISION B of the type Sierra Blanca limestone at L.S.J.U. locality 930, Indian Creek, Santa Barbara County.

Composition in pct.	*Samples*			
	930 K	930 P	930 Q	930 R
$CaCO_3$	90.60	97.00	98.80	98.00
CaO	50.73	54.32	55.33	54.88
MgO	3.00	0.71	0.32	0.66
$\{Al_2O_3$ $\{Fe_2O_3$	1.80	0.94	0.56	0.66
SiO_2	1.60	0.96	0.24	0.42
P_2O_5	br.tr.	br.tr.	trace	none

The CaO determinations are probably a little high, those of MgO are correct, and those of SiO_2 may be low, according to the analyst.

It is to be noted that the percentage of calcium carbonate ranges from 90.60 to 98.80 and that the magnesium oxide varies between 3.00% and 0.66%, which is less than that given in the composite analysis of 345 limestones by Clarke.[13]

FOSSILS IN THE LIMESTONE AT ITS TYPE LOCALITY

The fossils from the Sierra Blanca limestone at its type locality were identified by means of random-cut thin sections and polished surfaces of the rocks, but individual specimens were extracted from the matrix at the Los Sauces Creek locality (Loc. II, fig. 1).

Foraminifera. An orbitoidal foraminifer that appears to be identical with *Discocyclina psila* Woodring is the most abundant and best preserved fossil in the upper 115 feet of the limestone in the Indian Creek section. This species is the *"Orthophragmina"* referred to by Nelson[14]

[13] CLARKE, FRANK W., The Data of Geochemistry; U. S. Geol. Surv. Bull. 770, 1924, p. 30.

[14] NELSON, R. N., Op. cit., p. 352.

and the *Discocyclina,* sp. indet. of Schenck.[15] A photomicrograph of a part of a thin section showing the abundance of this orbitoid is reproduced in Plate 3, figure 6. There are, however, two varieties of *Discocyclina* at the type area of the Sierra Blanca limestone, *D. psila* Woodring and a thin undulating or wavy form. The test of the thinner form is slightly thicker at the center than at the periphery. No definite mamelon was observed. The average diameter of 14 specimens is 4 mm., with a range of from 2 mm. to 5 mm. The average thickness of the test is 0.25 mm., with 3 to 5 rectangular overlapping lateral chambers. Definite pillars extend to the surface of the test from the tops of these lateral chambers. Rectangular equatorial chambers form the equatorial layer, which has an average thickness of about 40 microns. A random-cut thin section exposed the nucleoconch of one of these thin forms, and, as in the case of *psila*, it consists of an initial spherical chamber partly embraced by a larger second chamber. The smaller chamber has a diameter of 70 microns, while the entire nucleoconch has a maximum diameter of approximately 150 microns.

Since all measurements on this form were made from random-cut sections, and since no individual specimens are obtainable, the writer hesitates to venture the opinion that this thin form is more than a variety of the more common form, for it might also be a dimorphic generation of the same species. More detailed work on it may show that its characters are of specific value.

Although reported from the Sierra Blanca limestone by Nelson and Schenck,[16] not a single specimen of stellate orbitoid was observed during the examination of 26 thin sections and 36 polished sections of the material from the type section (Indian Creek) of the Sierra Blanca limestone. It may be said, though, that stellate orbitoids do occur in limestone collected by Nelson at the head of Cachuma Creek (Loc. RNN 3-11), which is about 6 miles west of the most westerly exposure of the Sierra Blanca limestone. Except for the presence of the stellate orbitoids, this limestone appears to be identical with certain horizons of the limestone at Indian Creek, and more collecting may show that the Sierra Blanca limestone at its type area carries stellate orbitoids.

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[15] SCHENCK, H. G., Discocyclina in California; Trans. San Diego Soc. Nat. Hist., Vol. 5, No. 14, pp. 227-228, pl. 30, fig. 1, 1929.

[16] NELSON, R. N., and SCHENCK, H. G., Eocene Algae and Stellate Orbitoids from the Santa Ynez Range, California; Bull. Geol. Soc. Am., Vol. 42, p. 371, 1931; also Pan. Am. Geol., Vol. 54, p. 240, 1930.

The question might be considered as to whether the stellate orbitoids in the limestones here considered are *Actinocyclina* or *Asterocyclina.* According to diagnoses of various writers, the former has a greater number of radial rays than *Asterocyclina,*[17] in which the 3 to 6 rays "terminate in protuberant angles on the margin of the test,"[18] as is well shown in Gümbel's illustration[19] of *"Orbitoides" stellata* d'Archaic.

The attempt to differentiate the two stellate orbitoids is probably unwarranted, as they are obviously closely related, and little is known of the microspheric and megalospheric generations in the orbitoids. Moreover, the geologic range of the forms seems to be identical. Therefore, the reasonable attitude appears to be that of Woodring,[20] who uses *Actinocyclina* "as a genus to embrace all species bearing stellate rays."

Calcareous algae. The three genera of calcareous algae recognized in the Sierra Blanca limestone are *Lithothamnium, Lithophyllum,* and *Archaeolithothamnium.* Specific identifications have not been attempted because of lack of oriented thin sections and also because of lack of time.[21] The three genera are commonly found in rocks of Eocene age throughout the world. The algae making up some of the rock are of the encrusting type, for the most part reaching a maximum diameter of about 5 centimeters. Some of them grew around pebbles, the early chambers of *Discocyclina,* or fragments of mollusk shells. The greater abundance of these fossils at the type locality of the Sierra Blanca limestone is in the lower 160 feet of the section.

This abundance of algae in the lower part of the limestone, together with the dense, massive, very pure (see Chemical Analyses, p. 70) charcter of these beds as compared to the much more terrigenous upper portion of the limestone, which, moreover, contains fossils echinoids, mollusks,

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17 DOUVILLE, HENRI, Revision des Orbitoïdes, 2 pt., Orbitoïdes du Danien et de l'Eocène; Bull. Soc. Géol. France, 4th ser., Vol. 22, 1922, pp. 93, 95.

GALLOWAY, J. J., A Revision of the Family Orbitoididae; Jour. Paleo., Vol 2, 1928, p. 58.

18 VAUGHAN, T. W., Family 45. Orbitoididae; in Cushman, Foraminifera, their Classification and Economic Use; Spec. Publ. Foram. Research, No. 1, 1928, p. 344.

19 GÜMBEL, C. W., Beitrage zur Foraminiferenfauna der Nordalpinen Eocängebilde; Abh. der Math.-Physik. Cl. der k.-Bayerischen Ak. der Wiss., 10 Vol., 2nd Abt., 1868, pl. 4, fig. 4.

20 WOODRING, W. P., Upper Eocene Orbitoid Foraminifera from the Western Santa Ynez Range, California, and their Stratigraphic Significance; Trans. San Diego Soc. Nat. Hist., Vol. VI, No. 4, 1930, p. 151.

21 Dr. Marshall A. Howe, who kindly examined several thin sections of the limestones from Santa Barbara County, stated in a letter to H. G. Schenck, in December, 1927, that the *Archaeolithothamnium* from Cachuma Creek, figured on Plate 4, fig. 5, is not closely allied to *A. affine,* which is a shrubby species with more or less terete branches, while the Californian form is evidently a more massive crustaceous form.

and Foraminifera characteristic of the littoral zone of the sea, doubtless points to different conditions existent during the deposition of the lower beds of limestone than those prevailing during the deposition of the beds of the upper part of the section. More detailed study than time has permitted would be necessary to determnie the exact nature of these conditions.

AGE AND CORRELATION

The presence of *Discocyclina* and stellate orbitoidal Forminifera and the genera of calcareous algae recognized in the Sierra Blanca limestone suggest at once an Eocene age for the rock, but the fossils alone are not conclusive proof because *Discocyclina,* although unknown in the Oligocene, is present in uppermost Cretaceous rocks in Europe, and *Archaeolithothamnium* is thought by Pia to have had its maximum development in upper Cretaceous time. However, the limestone in question rests with probable unconformity upon beds of Chico (upper Cretaceous) age. The most convincing evidence of the age of the limestone is that its faunal content and stratigraphic relations show that it is the correlative of other limestones in California where there is additional evidence to prove that they are Eocene.

Besides the type area of the Sierra Blanca limestone, there are five other known localities in Santa Barbara County where orbitoid-bearing limestones of Teritiary age occur, as shown on the map, Fig. 1. The stratigraphic relations of the beds at these localities are shown graphically in Fig. 3, page 74. The writer examined samples from each of these localities, and careful comparisons with the type Sierra Blanca were made.

At Mono Flats (Locality I, Fig. 1 and Column I, Fig. 3), there is limestone said to be of Miocene age by Kew[22] and Nelson.[23] The limestone carries abundant foraminifers, among which is *Discocyclina californica* Schenck (Plate 3, fig. 5), the first observed occurrence of this species in southern California. *Actinocyclina* is also present. The evidence, therefore, strongly favors an Eocene rather than a Miocene age for the formation.

The section in Cañada de los Sauces (Loc. II, Fig 1 and Column II,

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22 KEW, W. S. W., Geology of a part of the Santa Ynez River District, Santa Barbara County, California; Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 12, 1919, p. 14.

23 NELSON, R. N., Op. cit., p. 362.

24 WOODRING, W. P., Trans. San Diego Soc. Nat. Hist., Vol. VI, No. 4, pp. 145-170, pls. 13-17, 1930.

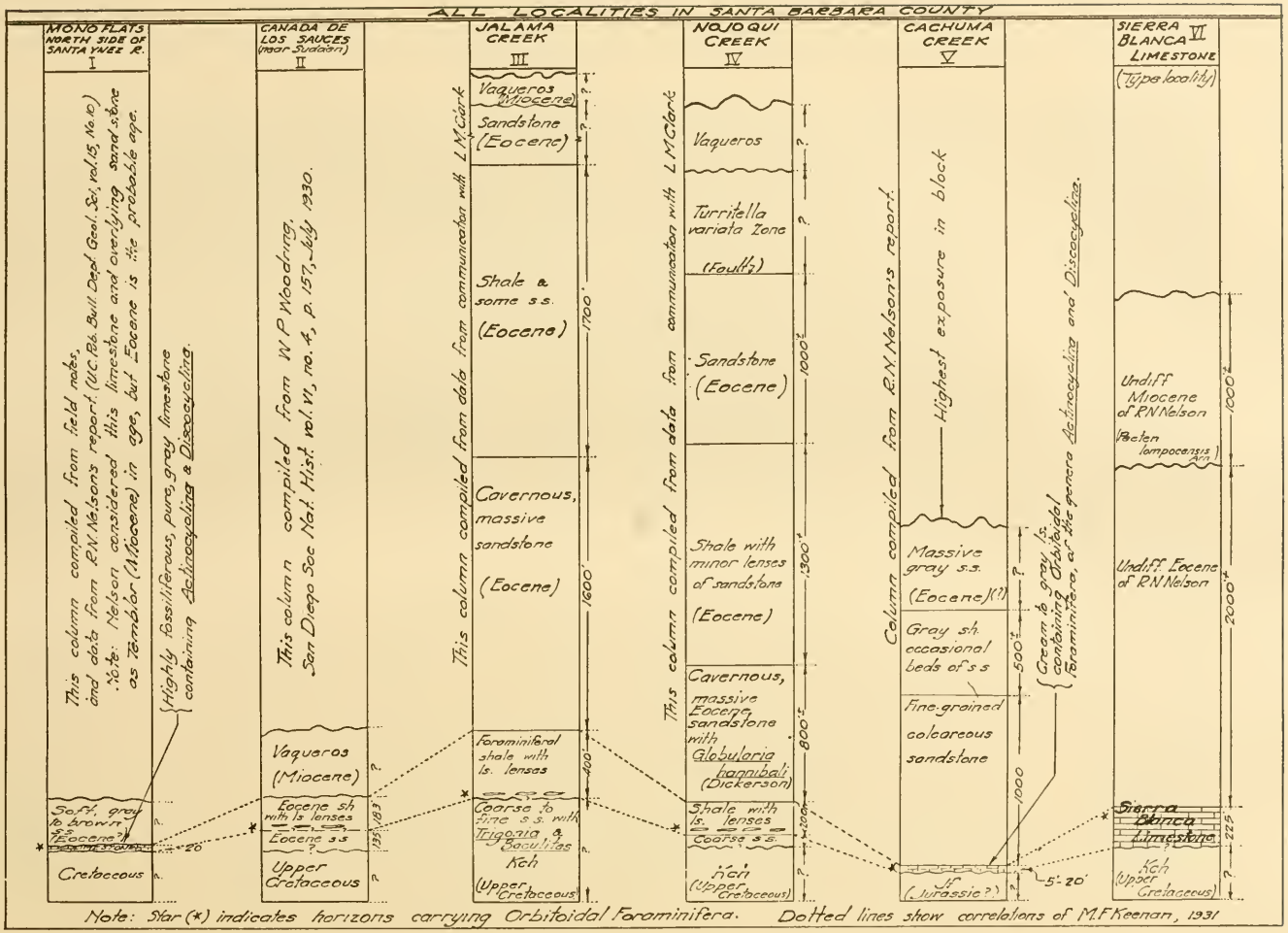

Fig. 3. Chart showing proposed correlation of orbitoid-bearing limestones found at several localities in Santa Barbara County, California.

Fig. 3) has been discussed by Woodring.[24] The unconformity at the base of the Vaqueros (Miocene) formation is worthy of especial note.

The Jalama Creek section (Loc. III, Fig. 1 and Column III, Fig. 3) also presented valuable evidence for the correlation of the limestones. I am indebted to Mr. L. M. Clark for the following data:

Fossiliferous upper Cretaceous beds with *Baculites* and *Trigonia* are overlain with possible unconformity by 300 feet of coarse sandstone, which, in turn, is overlain by 400 feet of shale with lenses of limestone at the base. These limestone lenses contain *Actinocyclina* and *Discocyclina* like those from the type locality of Woodring's species (see Plate 3, fig. 4). Above the shale are 3300 feet of massive Eocene sandstones and shales, which are overlain by Coldwater (Eocene) sandstone.

The sequence of formations in Nojoqui Creek (Loc. IV, Fig. 1 and Column IV, Fig. 3) are, according to L. M. Clark, as follows: Upper Cretaceous shales are unconformably overlain by coarse sandstone 10 to 75 feet thick, and conformably above this are shale beds with orbitoidal limestone lenses, aggregating 200 feet in thickness. Above the shale are 800 feet of cavernous-weathered, massive Eocene sandstone from which *Globularia hannibali*—pointing to a Domengine age—has been obtained. Still higher stratigraphically are 2300 feet of sandstone and shale beds, also of Eocene age. The much-disputed *Turritella variata*-bearing sandstones, in fault contact with these beds, are succeeded unconformably by Vaqueros (lower Miocene) strata.

Orbitoidal limestone in Cachuma Creek (Loc. V, Fig. 1 and Column V, Fig. 3) rests on the Franciscan formation and is overlain by Eocene rocks attaining a thickness of at least 1500 feet. The limestone is exposed at L.S.J.U. loc. 1106 (equals RNN 3-11) and carries abundant calcareous algae, *Actinocyclina,* and *Discocyclina,* of the same species as found at Cañada de los Sauces (Plate 3, fig. 3).

Even if the above evidence were not sufficiently in favor of the middle Eocene age of the Sierra Blanca limestone, additional occurrences of orbitoid-bearing Eocene rocks elsewhere in California should be convincing. On the south side of Mount Diablo, Contra Costa County, there is a thick section of Eocene strata which has been described by several geologists, the latest being B. L. Clark, who classified certain of the strata as "Meganos".[25] At the base of these "Meganos" strata, Mr. Leslie

[25] CLARK, B. L., The Stratigraphic and Faunal Relationships of the Meganos Group, Middle Eocene of California; Jour. Geol., Vol. 29, 1921, p. 140.

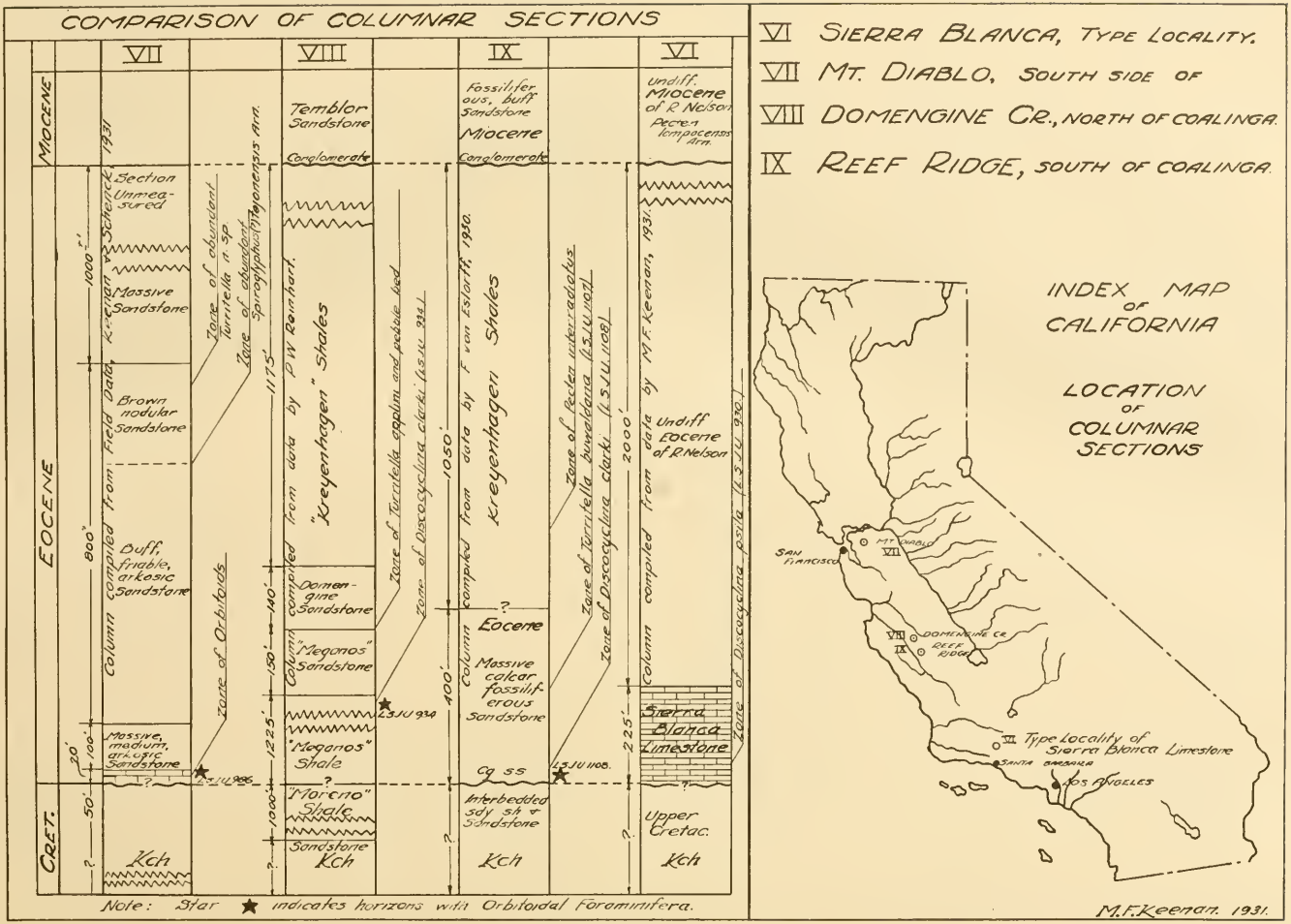

Fig. 4. Columnar section at the type area of the Sierra Blanca limestone compared with other sections in the central part of California, showing that orbitoid-bearing strata often occur considerably below the top of the Eocene.

Whipple discovered orbitoidal limestone[26], and through the courtesy of Professor B. L. Clark the locality description and thin sections were turned over to the writer, who later, with H. G. Schenck, measured the section (L.S.J.U. loc. 986) represented graphically in Fig. 4, Column VII.

Although the mollusks collected from the sandstones above the orbitoidal limestone show that the formation is younger than the Meganos formation at its type area, there is little question but that the limestone is older than Tejon as restricted by post-1916 usage.

Discocyclina-bearing rocks from the Eocene of the west side of the San Joaquin Valley, California, north of Coalinga, together with a stratigraphic section, are available through the courtesy of Mr. P. W. Reinhart (Fig. 4, Col. VIII.). No stellate orbitoid was found. *Discocyclina clarki* (Cushman)[27] is common in the so-called Meganos (*Turritella andersoni*-bearing strata), but was not found in the Domengine sandstone, as restricted by B. L. Clark. South of Coalinga, along Reef Ridge, the Avenal sandstone (or Domengine of Clark) carries *Discocyclina clarki,* according to von Estorff,[28] whose generalized geologic column, supplemented by personal notes, is presented as Column IX, Fig. 4.

Summarizing the data available, it is seen that the Sierra Blanca limestone at its type area is younger than Chico (upper Cretaceous) and older than Temblor (middle Miocene). Correlatives of the limestone are either slightly older than or the same age as the Domengine sandstone and younger than Chico. On the basis of the evidence at hand, therefore, the writer places the age of the Sierra Blanca limestone as middle Eocene, in the sense that it is younger than the Martinez formation (Paleocene or lower Eocene) and older than the Tejon formation as exposed at its type locality and, therefore, probably older than the Bartonian and Ludian ages, of European usage. The Sierra Blanca limestone may have been deposited during either upper Meganos or lower Domengine time.

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26 The reader should bear in mind that all the rocks herein referred to as "limestone" vary greatly in purity; none approaches certain samples of the type Sierra Blanca limestone in high degree of purity.

27 During the study of the specimens of *Discocyclina* from the Sierra Blanca limestone, the writer made thin sections of numerous topotypes of *Discocyclina clarki* (Cushman). After considerable difficulty, he was able to detect the essential morphologic features, and is able to state with assurance that *Discocyclina clarki* is not a *Pseudophragmina*.

28 VON ESTORFF, FRITZ E., Kreyenhagen Shale at the Type Locality, Fresno County, California; Bull. Amer. Ass. Petr. Geol., Vol. 14, No. 9, 1930, p. 1326.

Register of Localities

L.S.J.U. Localities:

356 Lompoc Quad.; $4\frac{7}{8}$ miles N. 44° W. of the Point Conception light house, Santa Barbara County, California. Eocene orbitoidal limestone, collected by W. S. W. Kew, H. L. Driver, and W. P. Woodring.

357 Guadalupe Quad.; in Cañada de los Sauces, 1.1 miles from railroad track, or 5.0 miles S. 82.5° E. of Pt. Arguello light house. Eocene orbitoidal limestone collected by W. S. W. Kew, H. L. Driver and W. P. Woodring.

930 Santa Ynez Quad.; at intersection of Indian Creek with limestone beds which dip to the north; about 4 miles south of Big Pine Mountain. U. S. G. S. topographic map location: 27 mm. south and 13 mm. east of intersection of Long. 119° 40′ W. and Lat. 34° 40′ N. Sierra Blanca limestone. Fauna: Foraminifera, echinoids, mollusks, brachiopods, etc. Flora: Algae. Collected by M. F. Keenan, Sept., 1930. (identical with R.N.N. 4-25).

931 Santa Ynez Quad.; just north of the Sierra Blanca limestone, in the north bank of the south fork of the westerly branch of Indian Creek. U. S. G. S. topographic map location: 17 mm. south and 1 mm. east of intersection of Long. 119° 40′ West and Lat. 34° 40′ N. Miocene (Temblor). Fauna: *Pecten lompocensis,* etc. Collected by M. F. Keenan, Sept., 1930.

932 Santa Ynez Quad.; at intersection of fork of Indian Creek with the northerly part of the Sierra Blanca limestone. U. S. G. S. topographic map location: 24 mm. south and 9 mm. east of intersection of Long 119° 40′ W. and Lat. 34° 40′ N. Sierra Blanca limestone. Fossils: Foraminifera. Collected by M. F. Keenan, Sept., 1930.

934 Coalinga Quad.; west central part of $SW\frac{1}{4}$ of $NW\frac{1}{4}$ of $SW\frac{1}{4}$ of Sec. 29, T. 18 S., R. 15 E., Mt. Diablo B. L. & M. Top of dark-gray clay shale, just north of Domengine Creek. Eocene (Meganos of Clark, 1926). Fauna: Foraminifera. Collected by P. W. Reinhart, April, 1931.

936 Santa Ynez Quad.; on hillside just north of East Fork of Santa Cruz Creek, on line of Lat. 34° 40′ N. and 15 cm. from eastern border of quadrangle, measured on U. S. G. S. topographic map. Siliceous shale; Miocene (Temblor). Fossils: Foraminifera. Collected by M. F. Keenan, 1931.

937 Santa Ynez Quad.; just below top of ridge on north slope of hill (Forest Service road will make a cut and fill over the locality). U. S. G. S. topographic map location: 22 mm. west and 15 mm. south of intersection of Long. 119° 40′ W. and Lat 34° 40′ N. Cretaceous. Fossils: ammonites. Collected by M. F. Keenan and H. E. Wheeler, March, 1931.

938 Santa Ynez Quad.; located on U. S. G. S. topographic map, 10 mm. east of B.M. 1410, at "Mono Flats" on Mono Creek, just north of its junction with the Santa Ynez River. Eocene (mapped as Miocene by Kew (1919) and Nelson (1925)). Fossils: brachiopods, *Spiroglyphus, Actinocyclina, Discocyclina.* Collected by M. F. Keenan, 1931.

985 Lompoc Quad.; west side of Nojoqui Canyon, 1.7 miles due east of Hill 1921, 3 miles south of Buelton. Limestone lenses in sandstone which unconformably overlies Cretaceous shales (Chico). Limestone is overlain by beds of sandstone carrying *Globularia hannibali* Dickerson, and orbitoid Foraminifera are found in the limestone. Domengine (Eocene). Collected by L. M. Clark, 1930.

986 Mt. Diablo Quad.; in road-cut east of Hill 2018, U. S. G. S. topographic map, 2.2 miles S. 30° W. of top of Mt. Diablo. "Meganos" formation. *Actinocyclina, Discocyclina,* etc. occur in bed of impure limestone characterized by high glauconite content. This limestone bed is traceable to the west to the top of Hill 2018. This locality equals U. C. loc. A-920. Collectors, H. G. Schenck and M. F. Keenan, July, 1931.

1106 Santa Ynez Quad.; west bank of the East Fork of Cachuma Creek, just north of right-angled bend in stream, R. 28 W., T. 6 N. $3\frac{4}{5}$ miles west and $\frac{2}{5}$ mile south (to scale of U. S. G. S. topographic map) of intersection of Long. 119° 40′ W. and Lat 30° 40′ N. Sierra Blanca limestone. Fossils: orbitoidal Foraminifera. (equals RNN 3-11 and also U.C. loc. 4124). Collected by M. F. Keenan.

PLATE 2

Fig. 1. View of Sierra Blanca Mountain, Santa Barbara County, California. The peak is 4700 feet above sea level. The Sierra Blanca limestone rests upon Cretaceous shale on the south side of the mountain.

Fig. 2. View of the rocks exposed on the west side of Indian Creek canyon, Santa Barbara County, California. The Sierra Blanca limestone may be seen on the extreme right, underlain by gray Cretaceous shale, below which are massive sandstone beds.

Fig. 1

West side Indian Creek canyon
1000±
Mono shale of E.N. Nelson
massive sandstone beds
gray shale
Sierra Blanca limestone of Nelson

Fig. 2

PLATE 3

Fig. 1. *Actinocyclina* in vertical section; thin section of limestone from the south side of Mount Diablo, Contra Costa County, California, L.S.J.U. locality 986. *Pleisiotype*, No. 5058; Slide No. 1152, type collection, Micropaleontology Laboratory, Stanford University. (x 14).

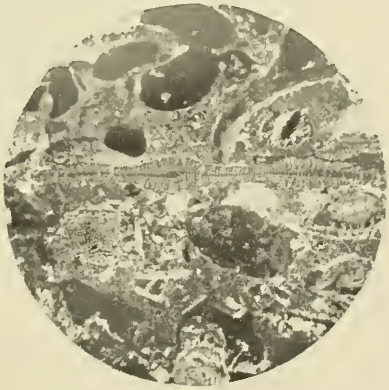
Fig. 2. *Discocyclina* in equatorial section; from limestone on the south side of Mount Diablo, Contra Costa County, California, L.S.J.U. locality 986. *Plesiotype*, No. 5056; Slide No. 1150, type collection, Micropaleontology Laboratory, Stanford University. (x 22).

Fig. 3. Thin section of limestone from L.S.J.U. locality 1106 (=RNN 3-11), east fork of Cachuma Creek, Santa Barbara County, California. *Actinocyclina* and *Discocyclina* are common at this locality. *Plesiotype*, No. 5055; Slide No. 1149, type collection, Micropaleontology Laboratory, Stanford University. (x 10).

Fig. 4. Thin section of limestone from L.S.J.U. locality 356, which is in Jalama Creek, $4\frac{7}{8}$ miles N. 44° E. of the Point Conception light house, Santa Barbara County, California. The abundance of *Discocyclina psila* Woodring and smaller foraminifers in the rock may be judged from this figure. Slide lost; (see Slide No. 1154, type collection, Micropaleontology Laboratory, Stanford University, from the same locality). (x 12 approx.).

Fig. 5. Thin section of limestone from near Mono Flats, Santa Barbara County, California, L.S.J.U. locality 938. Besides the *Discocyclina californica* Schenck figured here, specimens of *Actinocyclina* were found in the same rock. *Plesiotype*, No. 5050; Slide No. 1144, type collection, Micropaleontology Laboratory, Stanford University. (x 9).

Fig. 6. Thin section of the Sierra Blanca limestone at its type locality, L.S.J.U. locality 930, Santa Barbara County, California. The view shows the abundance of *Discocyclina psila* Woodring. *Plesiotype*, No. 5051; Slide No. 1145, type collection, Micropaleontology Laboratory, Stanford University. (x 6).



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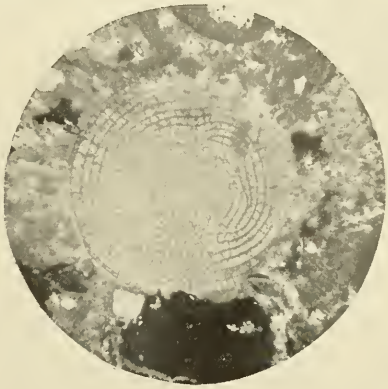

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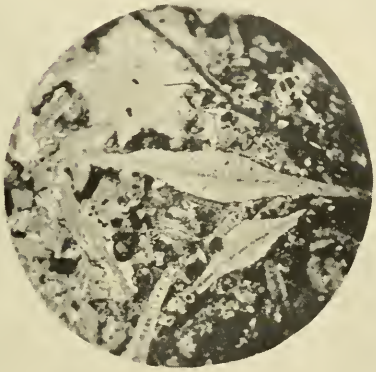

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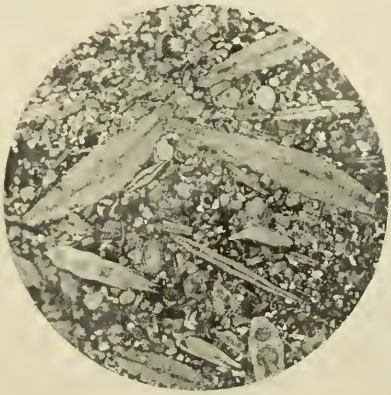

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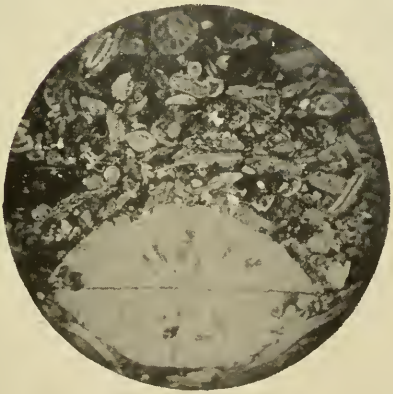

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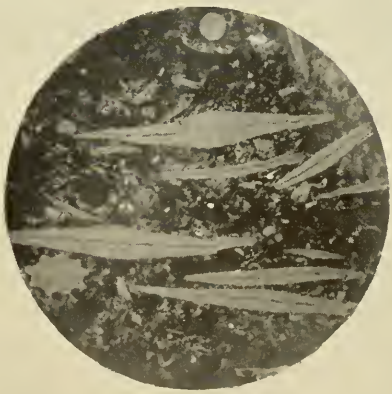

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PLATE 4

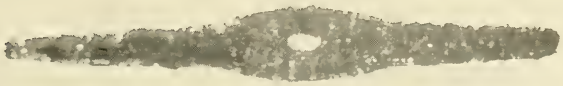
Fig. 1. *Discocyclina clarki* (Cushman) in vertical section. A topotype from Domengine Creek, Fresno County, California, L.S.J.U. locality 934. *Plesiotype,* No. 5052; Slide No. 1146, type collection, Micropaleontology Laboratory, Stanford University. (x 27).

Fig. 2. *Discocyclina clarki* (Cushman) in equatorial section. A topotype from Domengine Creek, Fresno County, California, L.S.J.U. locality 934. *Plesiotype,* No. 5054; Slide No. 1148, type collection, Micropaleontology Laboratory, Stanford University. (x 16).

Fig. 3. Limestone from Cachuma Creek, Santa Barbara County, California, L.S.J.U. locality 1106. The section shows a species of *Archaeolithothamnium* and vertical sections of *Actinocyclina* and *Discocyclina. Plesiotype,* No. 5059; Slide No. 1153, type collection, Micropaleontology Laboratory, Stanford University. (x 12).

Fig. 4. Limestone from L.S.J.U. locality 930, in the type area of the Sierra Blanca limestone. The view shows a thallus of *Lithothamnium,* traversed by numerous calcite veins. *Plesiotype,* No. 5053; Slide No. 1147, type collection, Micropaleontology Laboratory, Stanford University. (x 25).

Fig. 5. Limestone from L.S.J.U. locality 1106, Cachuma Creek, Santa Barbara County, California, showing *Archaeolithothamnium. Plesiotype,* No. 5057; Slide No. 1151, type collection, Micropaleontology Laboratory, Stanford University. (x 26).



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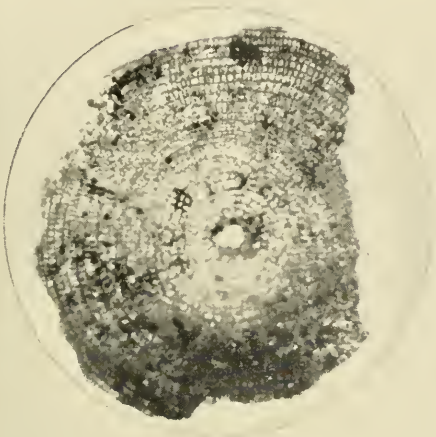

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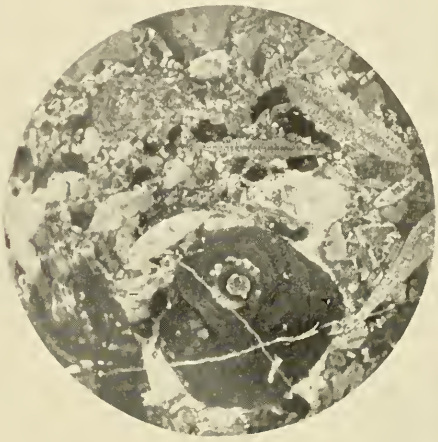

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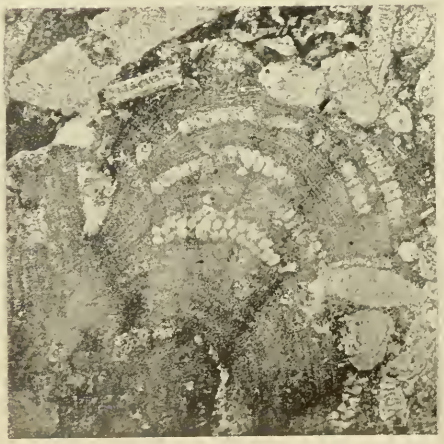

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TRANSACTIONS

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OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 9, pp. 85-90, plate 5

A NEW CARDITA FROM THE ALEUTIAN ISLANDS AND A NEW EPITONIUM FROM SOUTHERN CALIFORNIA

BY

GEORGE WILLETT

Los Angeles Museum

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

APRIL 15, 1932

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A NEW CARDITA FROM THE ALEUTIAN ISLANDS AND A NEW EPITONIUM FROM SOUTHERN CALIFORNIA

BY

GEORGE WILLETT

Los Angeles Museum

During the summer of 1926 the writer spent several days on Umnak Island, west of Unalaska Island, in the Aleutian group, and in spare moments a small collection of shells was made. Among these were examples of a small *Cardita* which eluded identification with any known species. Many valves of this shell were found on the beaches along the south shore of Umnak Island, together with valves of *Astarte rollandi* Bernardi. As this shore is entirely open and exposed to heavy swells, most specimens found were badly worn, but careful search produced some fairly good material, though all the valves were disconnected.

Owing to the fact that the little *Cardita* was so common in the beach-drift, it seemed unlikely that it represented an unknown species. Therefore, though the writer had been unable to identify it, he was very hesitant to believe it undescribed. Dr. W. P. Woodring, of the U. S. Geological Survey, kindly volunteered to compare it with material in the U. S. National Museum collection and examples were sent on to him for that purpose. In a letter of recent date he states that he has been unable to find a similar shell in the National Museum. Therefore it would seem that it requires a name, which may be as follows:

Cardita umnaka sp. nov.

Plate 5, figs. 1a, b, 2a, b

Description.—Shell small, inequilateral, somewhat oblique; with about forty narrow, raised, cord-like radial ribs, which run to the margin of the shell, but are frequently interrupted by the rough growth lines; interspaces about the same width as the ribs. Shell covered by a brown epidermis, which is much darker in adult specimens than it is in younger ones. The ribs, owing to their fineness are not visible through this epidermis, but may be seen only where it has been worn away, which is the case in the umbonal region of all specimens examined.

The valves designated as the type pair, No. 1034, collection of the

Los Angeles Museum, were selected from a large number of single valves collected by the writer on Umnak Island, Alaska, July, 1926, and are figured on Plate 5. Paratypes are in the U. S. National Museum, Academy of Natural Sciences of Philadelphia, San Diego Society of Natural History (Nos. 391, 392), University of California at Los Angeles (Cat. No. 1406), and the collection of the writer.

The type measures in millimeters: height, 10.7; length, 10.3; diameter, 6.6. The largest valve found has a height of 11.7 and a length of 11.2 millimeters.

This species differs from all known west coast Carditas in the greater number and fineness of the radial ribs. No living specimens having been taken, it is not possible to state whether the epidermis is ever entire on adult shells. If a specimen should be entirely covered by the epidermis, the ribs would be visible only on the inner margin.

During recent years considerable work has been done on the shells of the genus *Epitonium* and it has been generally believed by southern California collectors that our local shore and shallow water species were fairly well known. Therefore it was a surprise to the writer to find, while dredging in twenty fathoms off San Pedro, California, two specimens of a member of this genus that differ decidedly from any of our known species. This may be known as:

Epitonium (Nitidiscala) pedroanum sp. nov.

Plate 5, fig. 3

Description of type.—Shell small, slender, thin, buffy-white; with ten whorls exclusive of the (lost) nucleus; varices fifteen, very low, slightly reflected, with no perceptible shoulder, and almost encircling the spire; whorls and base rounded; aperture oval, somewhat angled. Length, 11.7; maximum diameter, 3.7.

Type No. 1036, collection of the Los Angeles Museum. The type and another smaller specimen were collected by G. Willett in 20 fathoms off San Pedro, California, September 9, 1931. Paratype in the collection of the writer.

This species does not closely resemble any west coast *Epitonium*

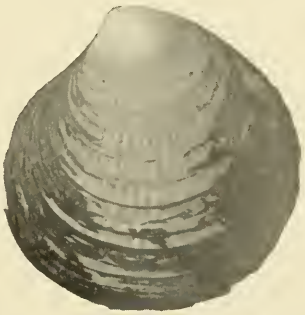
known to the writer. The varices in form are somewhat similar to those of *E. columbianum* Dall and the unshouldered variety of *E. sawinae* which Dr. Dall called *catalinense*. The varices of *pedroanum,* however, are fewer in number than in either of these species, and the shell is much more slender and of a different color. Furthermore *pedroanum* is much smaller than *columbianum* and longer than *sawinae*.

PLATE 5

Figs. 1, 2. *Cardita umnaka* Willett, type specimen, No. 1034, collection of the Los Angeles Museum. Fig. 1a, exterior of right valve; fig. 1b, interior of right valve; fig. 2a, exterior of left valve; fig. 2b, interior of left valve. × 4.

Fig. 3. *Epitonium pedroanum* Willett, type specimen, No. 1036, collection of the Los Angeles Museum. × $4\frac{1}{2}$.

1 a



2 a

1 b

3

2 b

28,898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 10, pp. 91-110, plate 6, text figs. 1-12

FOSSIL CORALS OF THE GENUS TURBINOLIA FROM THE EOCENE OF CALIFORNIA

BY

E. H. QUAYLE

Research Associate in Corals, San Diego Society of Natural History

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SAN DIEGO, CALIFORNIA

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INTRODUCTION

The first record of the genus *Turbinolia* in California was by Dickerson[1] who used it as the indicator of his "Turbinolia Zone." He made no attempt to classify the species systematically, but recorded "*Turbinolia* n. sp. (a) (long)"[2] and "*Turbinolia* n. sp. (b) (short)."[3] Dickerson's specimens have not been preserved and consequently his identifications cannot be checked.

Nomland[4] was the first who systematically named species of this genus from California, when he described *Turbinolia dickersoni* and *T. pusillanima.* He made no reference to Dickerson's "long" and "short" species. Nomland's types are, at present, missing from the University of California Museum of Paleontology and therefore were unavailable for the present study. From the literature, however, the two species appear to be valid.

Marcus A. Hanna[5] described *Turbinolia jollaensis* and *Balanophyllia imbulata.* The latter is a valid species of the genus *Turbinolia,* but the former is a synonym of *T. pusillanima* Nomland.

All the specimens available in the various museums and universities of the State have been studied for the preparation of the present paper and collections have been made from the type localities. This material has furnished additional information regarding the previously described species and has brought to light one species that is described as new.

For the loan of material I am indebted to Dr. B. L. Clark of the

---

[1] DICKERSON, R. E., Note on Faunal Zones of Tejon Group, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 8, pp. 17-25, 1914.

[2] *Op. cit.* p. 20.

[3] *Op. cit.* pp. 20, 22.

[4] NOMLAND, J. O., Corals from the Cretaceous and Tertiary of California and Oregon, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 9, pp. 59-76, 1916.

[5] HANNA, M. A., An Eocene Invertebrate Fauna from the La Jolla Quadrangle, California, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 16, pp. 268, 269, pl. 24, figs. 1, 2, 3, 1927.

University of California; to Dr. J. E. Hoffmeister of the National Museum; to Dr. T. W. Vaughan of Scripps Institution of Oceanography; to Dr. H. G. Schenck of Stanford University; to Mr. C. H. Sternberg of San Diego and to Mr. Arthur Wrigley of London.

Acknowledgments are due especially to the late Professor J. P. Smith and to Professors W. K. Fisher, H. G. Schenck and G. F. Ferris of Stanford University for their personal interest and assistance.

For criticism of the manuscript and assistance in the geological correlations I am very greatly indebted to Dr. U. S. Grant, Dr. H. G. Schenck, Dr. B. L. Clark, Prof. A. Morley Davies, Royal School of Mines, London, and to Mr. Arthur Wrigley of London.

Dr. T. Wayland Vaughan has helped me in the systematic study, has furnished me with laboratory facilities, and has carefully corrected this manuscript. To him I wish to extend my sincerest thanks.

Phylum **COELENTERATA**

Class ANTHOZOA

Subclass Hexacoralla Haeckel

Order **MADREPORARIA** Verrill

Suborder IMPERFORATA

Family Turbinolidae Milne Edwards & Haime, in part

Genus **Turbinolia** Lamarack, in part

Turbinolia (in part) Lamarck, Hist. Nat. Anim. sans Vert., Vol. 2, p. 229, 1816; Milne Edwards & Deshayes Ed., 2nd ed., Vol. 2, p. 359, 1835.

Turbinolia Milne Edwards & Haime, Ann. Sci. Nat., 3ième sér. Zool., Vol. 9, p. 235, 1848; Brit. Foss. Corals, Introd. p. xvi, 1850; Hist. Nat. Corall., Vol. 2, p. 60, 1857. De Fromentel, Introduct., p. 91, 1861. Duncan, Journ. Linn. Soc. London Zool., Vol. 18, p. 18, 1885.

Diagnosis: Corallum simple, free, straight, and conical, with a circular calice. Wall a true theca. Costae always present and prominent, independent of each other, the principals opposite the septa. Intercostal furrows ornamented by a double or single row of pits, frequently with pores which perforate the wall, or in some species by transverse flutings near the base of the costae. Septa usually exsert in two, three or four

complete cycles, rarely incomplete in last cycle. Their margins usually entire, often folded or undulating along the inner margin. Their lateral faces more or less adorned with granulations. The primaries usually strongly fused to the columella. The secondaries weakly fused to the columella deep in the calice or free. Tertiaries often bending towards and fused to the included primaries or free. Quaternaries rudimentary and nearly always free. Columella essential, rising from the basal disc, styliform, stellate, compressed or granular.

Genotype (by subsequent designation, Milne Edwards & Haime, Brit. Foss. Corals, Introd. p. xvi, 1850) *Turbinolia sulcata* Lamarck, Eocene, Paris Basin. (See Plate 6, figs. 13, 14.)

Geological range: Eocene, Oligocene, and Recent(?).

Geographical distribution: Eocene, Europe and North America; Oligocene, North Germany and North America; Recent(?), Caribbean Sea.

Bathymetric range: 100 to 220 fathoms.

Remarks: With the new species, here described, there are nine species of *Turbinolia* recorded from North America as fossils and one as "perhaps fossil(?)."[6] There is nothing known of the habitat or life history of the genus, but Pourtalès' specimen would, if Recent, indicate warm water, a clear strong current and other conditions similar to those of the Gulf Stream along the north bank of Cuba at a depth of from 100 to 220 fathoms.

There is no indication of a basal attachment. The entire corallum appears to have been an internal skeleton, i. e. completely surrounded by the polyp. The individuals very likely lived like sea anemones partially embedded in sediment. The dead skeletons would accumulate by mechanical transportation with the small shells so often found associated with the fossils.

Only one of the American fossil species, *T. insignifica* Vaughan[7] from the Lower Oligocene Red Bluff beds of Mississippi, occurs in other than Eocene strata. The California species are confined to the Meganos and Domengine (including the Rose Canyon Shales of Hanna's La Jolla formation) and are valuable fossils for the correlation of these formations.

---

6 POURTALES, L. F. de, Bull. Mus. Comp. Zool., Vol. 5, no. 9, p. 203, pl. 1, figs. 12, 13, 1880.

7 VAUGHAN, T. W., U. S. Geol. Surv. Mon. 39, pp. 16 and 92, 1900.

Key to the North American Species

1. Columella stellate, fig. 1 2

   Columella not stellate, figs. 7, 8, 9 5

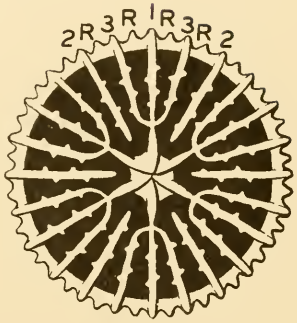

Fig. 1

2. (from 1) Rudimentary costae present opposite the interseptal loculi, fig. 1 (R, R.) 3

   Costae present only opposite the septa, fig. 2 4

Fig. 2

3. (from 2) Columella projecting well above the corallum wall, fig. 3 ..... *T. wautubbeensis* Vaughan

   Columella not projecting noticeably above the corallum wall, fig. 4 ..... *T. dickersoni* Nomland—p. 98

Fig. 3

4. (from 2) Twelve principal septa greatly swollen near the base, fig. 5 ..... *T. pharetra* Lea—p. 109

   Twelve principal septa not greatly swollen near the base, fig. 6 ..... *T. clarki* n. sp.—p. 100

Fig. 4

5. (from 1) Columella ending in a prominent style, fig. 7 6

   Columella more or less a granular irregular mass, not ending in a very prominent style, fig. 9 7

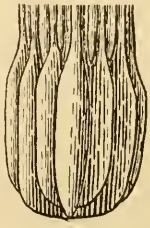
Fig. 5

KEY TO THE NORTH AMERICAN SPECIES—(Continued)

6. (from 5) Columella a hexagonal style, fig. 8; costal margins crenate, fig. 10.....*T. acuticostata* Vaughan

   Columella a round style, fig. 7; costal margins smooth and entire, fig. 11.....*T. insignifica* Vaughan

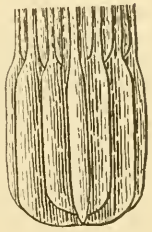

Fig. 6

7. (from 5) Twelve septa in two cycles.....*T. corbicula* Pourtalès

   Twenty-four septa in three cycles, fig. 1.....8

Fig. 7

Fig. 8

Fig. 9

8. (from 7) Costae much narrower than the intercostal spaces.....*T. claibornensis* Vaughan

   Costae as wide as the intercostal spaces.....9

9. (from 8) Septa thinner than the interseptal loculi, granules on septal faces sparse.....*T. pusillanima* Nomland—p. 101

   Septa as wide as, or wider than, the interseptal loculi, granules numerous in close compact rows.....*T. imbulata* (Hanna)—p. 103

Fig. 10

Fig. 11

Turbinolia dickersoni Nomland

Plate 6, figs. 1, 2, 3, 4, 5

Fifteen topotypes, three of which are complete specimens, furnish additional information regarding this species:

Turbinolia dickersoni Nomland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 9, p. 61, pl. 3, figs. 5, 6, 7, 8, 1916. Dickerson, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 9, pp. 372, 378, 385, 426, 430, 1916. Clark, Journ. Geol., Vol. 29, p. 158, 1921. Palmer, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 14, p. 306, pl. 56, figs. 2, 4, 1923. Clark, Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 16, p. 114, 1926.

Corallum conical, form varying from slender with a ratio[8] of .413:1, to stout with a ratio of .589:1. In fully mature specimens there are forty-eight costae, the twenty-four principals are very prominent and oppose the twenty-four septa. They extend from the margin of the calice to within one and one-half millimeters of the base, three-fourths to four-fifths the length of the corallum, where the twelve tertiaries end. The secondaries and primaries are equal along the basal quarter of the corallum, the secondaries not quite reaching the tip which is formed by the primaries. Where well preserved they are not flattened at their outer margin, and they are considerably wider at the thecal wall than near the margin. In cross-section they are roundly pointed. At the base of the corallum the primaries and secondaries are but slightly thickened. Their upper margin is entire and smooth. The rudimentary costae, twenty-four in number, begin, as the "low ridges" described by Nomland, at about four-fifths of the height of the corallum from the base, but attain the proportions of rudimentary costae near the calicular margin. The intercostal furrows are almost twice as wide as the costae and contain prominent double rows of pores which, in sectioned specimens, are, in many instances, seen to pass through the thecal wall. The wall is a true theca. There are twenty-four septa. The primaries and secondaries are equal, broadly arched at their upper margins which are entire and smooth. They are exsert above the calicular margin of the wall from five to seven tenths of a millimeter. The primaries are united to the rays of the columellar star at about the level of the calicular wall. The secondaries join it deeper in the calice. Their inner margins are transversely fluted. These flutings appear on the lateral faces as swellings which extend horizontally about one-fourth the distance from the inner margin toward the wall. In many instances, but not always, they coincide with the diagonal rows of granules. The tertiaries are a little less exsert than the members of the two higher cycles. Along their inner margins they bend toward, and are fused with, the included primary septa at about two-thirds the distance from the wall to the columella. The lateral faces of all the septa are ornamented with small granules. Those on the first two cycles of septa appear, in a longitudinal section, in diagonal rows sloping from the wall at an angle of from 15° to 30° in Nomland's figure 8. The angle is less acute in the topotypes sectioned. The

[8] The diameter of the calice to the height.

granules are numerous and crowded along the rows which do not meet the marginal folds of the septa with exact regularity. In cross sections of the septa they appear on the primaries as small spinules, three or four in number, arranged alternately. The columella is stellate, solid, and prominent. It occupies almost one-third of the calice. Its surface does not extend to the upper margin of the primary and secondary septa, but stands a little above the level of the calicular wall.

DIMENSIONS

	Holotype (Nomland)	*Plesiotype SDSNH 378*	*Plesiotype SDSNH 379*	*Plesiotype SDSNH 380*
Diam. of calice	2.8 mm.	3.3 mm.	3.1 mm.	2.6 mm.
Ht. of corallum	6.7 mm.	5.6 mm.	7.5 mm.	5.0 mm.
Ratio, diam. to ht.	.418:1	.589:1	.413:1	.520:1

Holotype: Said to be in the Univ. Calif. Museum of Paleontology.

Plesiotypes: Nos. 378, 379, 380, 381 San Diego Society of Natural History.

Topotypes: Nos. 32266, 32267 Univ. Calif. Museum of Paleontology. Nos. 371681, 371682 U. S. National Museum. Nos. 816, 817 Stanford Univ. Museum of Paleontology.

Type locality: U. C. locality 1817: "On branch of Salt Creek, near center of Sec. 15, T. 18 S, R. 14 E, M. D. B. & M., Fresno County, California, about 16 miles north of Coalinga." (University of California Locality Book.)

N. B. Nomland, *op. cit.*, erroneously gave Range "13" in citing the type locality.

Geological horizon: Meganos formation, Eocene.

Remarks: These topotypes correspond closely to Nomland's original description and figures. This species belongs, with *T. pharetra* Lea, *T. clarki* n. sp., and *T. wautubbeensis* Vaughan, to the group of *Turbinolia* possessing a prominent stellate columella. The presence of a fourth cycle of costae relates it closely to *T. wautubbeensis* Vaughan and separates it distinctly from *T. pharetra* Lea and *T. clarki* n. sp. It differs from *T. wautubbeensis* Vaughan by the less prominent columella which in the latter rises well above the upper margins of the principal septa.

The two specimens determined by Palmer[9] appear to be young and have not yet developed the fourth cycle of costae.

Moulds of this species were found in brown sandstone from the Meganos of Simi Valley, Ventura County, California, at. L. S. J. U. locality 2092. These are very slender with a ratio of .338:1.

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9 PALMER, *op. cit.*

Turbinolia clarki sp. nov.

Plate 6, figs. 6, 7, 8

Corallum elongate, conical, slender, the ratio of the diameter of the calice to the height in the syntypes being .400:1 (U.C. No. 32380) and .418:1 (U.C. No. 32381), simple and free. The wall is a true theca. Costae twenty-four in number, prominent, sharply rounded in profile, margins smooth and entire, equal in size at the calicular margin. Near the base the twelve costae corresponding to the primary and secondary septa are somewhat thicker and higher, the intermediate ones, the tertiaries, becoming very insignificant and eventually disappearing. Only the six primaries are prolonged to the basal tip, but the secondaries approach it closely. The intercostal furrows are about twice as wide as the costae and are ornamented by a double row of pits which in many instances are pores that pass through the corallum wall. The septa are moderately exsert, with entire margins, twenty-four in number, in three complete cycles. Their surfaces are moderately granulate on the half near the wall. Their inner margins are broadly undulating and the folds of the undulations extend half way to the wall where, usually, but not always, they coincide with the diagonal rows of granules. The granules, usually four or five in number, are arranged in parallel rows which descend from the wall at an angle of from 25° to 35°. The inner margins of the first cycle of septa are fused to the rays of the columellar star. The fused portion is broader than the intervening spaces and these points of fusion correspond in number to the folds along the inner margins. Occasionally in the lower portions of the corallum this fusion becomes solid. The inner margins of the second cycle of septa are more deeply fluted than are those of the first. Where the outer edges of the marginal fluting touches the sides of the columellar rays they are fused together. The inner margins of the third cycle of septa are invariably fused to the included member of the first cycle. The columella is essential, strong and stellate. The surface is very slightly below the upper margins of the septa.

Dimensions

	Syntype U.C.Mus.Paleo. 32380	*Syntype U.C.Mus.Paleo. 32381*	*Average of nine Paratypes*
Diam. of calice	2.35 mm.	2.3 mm.	2.19 mm.
Ht. of corallum	5.87 mm.	5.5 mm.	4.81 mm.
Ratio, diam. to ht.	.400:1	.418:1	.455:1

Syntypes: Nos. 32380, 32381 Univ. Calif. Museum of Paleontology.

Paratypes: Nos. 356, 357 San Diego Society of Natural History. Nos. 32261 to 32265 Univ. Calif. Museum of Paleontology. Nos. 371672, 371673 U. S. National Museum.

Type locality: U. C. locality 672: "SE$\frac{1}{4}$ of NW$\frac{1}{4}$ sec. 24, T. 18 S, R. 14 E, M. D. B. & M., Parsons Peak, 0-10 ft. below white shale. Domengine Ranch and Creek, Coalinga Quad., Fresno County, California." (University of California Locality Book).

N. B. This locality description should be modified to prevent misinterpreta-

tion regarding the very prominent white Oligocene(?) shales above the salmon colored and brown shales which weather out white and which rest directly above the Domengine sands in which the specimens of *Turbinolia* occur.

Geological horizon: Domengine formation, Eocene.

Remarks: Comparison of a series of eleven perfectly preserved specimens of this species with twenty-four typical specimens of *T. pharetra* Lea from Claiborne, Alabama, shows that their resemblances are extremely close. However, the columella is less exsert, and the twelve principal costae are consistently less swollen at the base, the angle formed by the rows of granules on the septal faces with the wall is more acute, 25° to 40°, the swellings on the inner margins of the septa are not as horizontal but slope a little upwards, and the transverse fluting, which causes these swellings, is more broadly undulating than in *T. pharetra* Lea. From *T. dickersoni* Nomland, the only other California *Turbinolia* with a stellate columella, it is readily distinguished by the total lack of rudimentary costae—the thin ridge between the rows of pores in the intercostal furrows is not a costal ridge—by the less acute angle formed by the rows of granules on the septal faces with the wall, by the fewer number of these granules, and the more prominent fluting of the inner margins of the septa, and the more prominently swollen costae near the base.

It is very probable that this species has been called *T. dickersoni* because of their general resemblance. The two species seem to be confined to different horizons as indicated in the accompanying correlation table.

Named in honor of Dr. B. L. Clark of the University of California.

Turbinolia pusillanima Nomland

Plate 6, figs. 9, 10

Turbinolia pusillanima Nomland, Univ. Calif. Publ. Dept. Geol. Sci., Vol. 9, p. 62, pl. 3, figs. 9, 10, 1916.

Turbinolia jollaensis Hanna, Univ. Calif. Publ. Dept. Geol. Sci., Vol. 16, p. 269, pl. 24, fig. 1, 1927.

Ten topotypes of this species furnish additional information which, for the sake of unity, is given in a redescription:

Corallum conical, slightly stout, the ratio of the diameter of the calice to the height being .500:1. Calice subcircular. Wall a true theca. The principal costae are twenty-four in number opposite the septa, with an equal number of rudimentary costae present in the upper third of the corallum opposite the interseptal loculi. Twelve of the principals end one-third of the height from the base. The primary and secondary cycles reach nearly to the base but only the six primaries form the basal tip. They are acute, almost sharp, their margins entire and smooth

except for irregular incisions which appear to be due to weathering. Along the central third of the corallum they are just about as wide as the intercostal furrows. In the basal third they are somewhat broader than the furrows. In the marginal third, where the rudimentary costae are present, they are thinner than the furrows. The rudimentary costae are considerably thinner than the principals but almost equal in height. In the intercostal furrows a double row of pits is present except between the rudimentary and principal costae where there is but a single row. The four cross sectioned specimens show these pits as distinct pores that perforate the wall. The septa are twenty-four in number, three complete cycles, arranged in six groups. They are fairly straight in two weathered-out specimens which are badly worn, but in the four cross sectioned specimens they have a wavy appearance near their inner margins. The lateral faces of the septa reveal no marked ornamentation, although a few minute granules occasionally occur in the cross sections and, in the longitudinal section, these can be detected in the upper region near the calice. Their alignment in rows is vaguely suggested. In the longitudinal section the folds of the inner margins of the septa, near their fusion with the columella, are regular and much more frequent than in the other California species of *Turbinolia*. The primary and secondary septa are weakly fused to the columella. The tertiaries are fused to the sides of the included primaries. The columella is very weakly developed. In the two weathered out calices it appears as a compressed granular mass that has not the remotest resemblance to a star. In the cross sections it is detectable as a small central column to which the six primary septa are irregularly fused.

Dimensions

	Holotype (Nomland)	*Plesiotype SDSNH 377*	*Plesiotype SDSNH 376*
Diam. of calice	3.3 mm.	3.2 mm.	3.7 mm.
Ht. of corallum	5.8 mm.	5.8 mm.	7.4 mm.
Ratio, diam. to ht.	(broken)	(broken)	.500:1

Holotype: Of *T. pusillanima* Nomland, said to be in the Univ. Calif. Museum of Paleontology. Of *T. jollaensis* Hanna, No. 31163 Univ. Calif. Museum of Paleontology.

Plesiotypes: Nos. 376, 377 San Diego Society of Natural History.

Topotypes: No. 32269 Univ. Calif. Museum of Paleontology. Nos. 371674, 371675 U. S. National Museum. No. 820 Stanford Univ. Museum of Paleontology.

Type locality: Of *T. pusillanima* Nomland, U. C. locality 476: "SW$\frac{1}{4}$ of NW$\frac{1}{4}$ sec. 22, T. 1 S, R. 1 E, M. D. B. & M., elevation 1200 ft., in little wash near creek, below 1250-foot hill, Diablo Quadrangle, Contra Costa County, California." Of *T. jollaensis* Hanna, U. C. locality 5091: "Tecolote Creek about 0.25 mile north of its junction with its largest tributary." San Diego County, California.

Geological Horizons: Meganos formation (U. C. locality 476), and Rose Canyon shale (U. C. locality 5091), Eocene.

Remarks: The study of Hanna's holotype in comparison with the

figures and the topotypes of *T. pusillanima* Nomland is convincing that *T. jollaensis* Hanna is a synonym of Nomland's species. Hanna's specimen, No. 31163 Univ. Calif. Museum of Paleontology, is sectioned below the rudimentary costae and corresponds precisely to Nomland's fig. 10, *op. cit.,* as well as to two similar cross sections amongst the topotypes at hand.

T. pusillanima Nomland belongs to the group of the genus which is characterized by the columella being a more or less granular mass. This group includes *T. acuticostata* Vaughan, *T. claibornensis* Vaughan, *T. corbicula* Pourtalès, and *T. imbulata* (Hanna). The three complete cycles of septa separate it from *T. corbicula* Pourtalès which has but two cycles. The smooth and entire costal ridges distinguish it from *T. acuticostata* Vaughan which has crenate costal margins. It differs from *T. imbulata* (Hanna) by the much thinner septa with sparse granulations on their lateral faces and by the weakly developed columella. Its nearest resemblance is to *T. claibornensis* Vaughan, but it is separable from this species by the less prominent granules on the septal faces and the much wider costae which are as wide as the intercostal spaces.

Careful collecting at U. C. locality 1817 does not authenticate the presence there of this species, as reported by Nomland, *op. cit.*

Turbinolia imbulata (Hanna)

Plate 6, figs. 11, 12, 15, 16

Balanophyllia imbulata Hanna, Univ. Calif. Publ. Dept. Geol. Sci., Vol. 16, p. 268, pl. 1, figs. 2, 3.

Hanna's description is based upon two cross sections and is wholly inadequate. Three specimens, one of which is a topotype, and a study of the holotype and paratype furnish the following additional information regarding the species:

Corallum conical, elongate, slender, and large for the genus. Calice subcircular. Wall a true theca, rather thin near the calice. Costae forty-eight in number, alternating in size. The twenty-four principal costae opposite the septa extend throughout the incomplete specimen labeled "Rose Canyon," SDSNH No. 359. The rudimentary costae arise about one-fourth the distance from the broken upper end to the broken base of this specimen. In profile they are rather sharp, the principal costae rise vertically as high as they are broad, then flare out slightly to form a spearhead which is very nearly an equilateral triangle with the points rounded off. This odd appearance is brought about by the pores along the intercostal furrows which undercut the sides of the costae. These pores are irregular in shape and in several instances in the cross sections are seen to penetrate the wall into the interseptal loculi. They are arranged in a double row and

alternate in position in the exposed portion of the "Rose Canyon" specimen. The septa are twenty-four in number, three complete cycles arranged in six groups. The primaries are broadly and the secondaries are narrowly fused to the columella. The tertiaries curve toward and fuse with the sides of the included primaries near the outer edge of the columella. In cross section the septa are irregularly undulating, the granulations on their lateral faces accentuating this irregularity. In transverse section the granules are seen to be arranged in close compact straight parallel rows which slope down from the wall at an angle of from 35° to 45°. The space between them is about half the width of the rows. They extend fully two-thirds the distance across the faces of the septa. Each alternate row of granules with a few exceptions ends opposite a small swelling formed by the transverse fold of the septal margin. As many as eight granules are found in a row. The septal margins are fused rather solidly to the columella. The columella is a rather solid mass of stereoplasm in six irregular sections, corresponding to the groups of septa, fused around a small central column. There is no marked line of separation between the thickened inner margins of the primary septa and the columellar mass except in one group of the topotype. The secondary septa are usually narrower at their point of fusion with the columella. There is a slight indication in the topotype that the surface of the columella stood well up in the calice.

Dimensions

	Topotype SDSNH 358	*Tecolote Canyon USNM 371683*	*"Rose Canyon" SDSNH 359*
Diam. of calice	4.1 mm.	3.6 mm.	2.4 mm.
Ht. of corallum	10.0 mm.	9.2 mm.	4.2 mm.
Ratio, diam. to ht.	.401:1	.390:1	(broken)

Holotype: No. 31166 Univ. Calif. Museum of Paleontology.

Paratype: No. 31167 Univ. Calif. Museum of Paleontology.

Plesiotypes: Nos. 358, 359 San Diego Society of Natural History.

Type locality: U. C. locality 5051: "At mouth of tributary to San Clemente Creek, due west of the "s" of Pueblo Lands [La Jolla topographic sheet of the U. S. Geological Survey], 40 ft. above the bottom of the creek. Elevation 225 feet." San Diego County, California.

N. B. A bed of hard indurated light brown sandstone containing a rich assortment of fossils and including this species occurs at the type locality.

Geological horizon: Rose Canyon shales, Eocene.

Remarks: A study of the holotype and paratype, which are cross sections only, proves that Hanna's *Balanophyllia imbulata* belongs to the genus *Turbinolia*. In the collection of the San Diego Society of Natural History there is a specimen, No. 359, collected by Mr. Frank Stephens, labeled "Rose Canyon." The matrix looks suspiciously like the San Clemente rock, but unfortunately the label is too general to allow this specimen to be considered a topotype. In cross section it is almost identical with the figure of *Balanophyllia imbulata* Hanna. From it the

costal and columellar characters have been described. In breaking up a piece of the hard indurated sandstone obtained at the type locality, Mr. C. H. Sternberg found the topotype and kindly donated it for this study. It is split longitudinally and reveals the septal faces and their ornamentation on both a primary and secondary septum. Another specimen, U. S. National Museum No. 371683, was collected by the writer from the type locality of *T. jollaensis* Hanna in Tecolote Canyon. It is also split longitudinally and reveals similar septal ornamentations.

T. imbulata (Hanna) is related to *T. claibornensis* Vaughan and to *T. pusillanima* Nomland by its granular, irregularly shaped columella and by the presence of rudimentary costae. It is separable from both species by its large size, the abundance of the granules on the septal faces and their arrangement in close compact rows, and by the thickness of the septa which are wider than the interseptal loculi and crowd the calice. In size it is equal to the larger of the European species of *Turbinolia* but none of these have the thick heavily ornamented septa nor the unique spearhead appearance of the costae when seen in profile or cross section.

DISCUSSION

There are no known records of the genus *Turbinolia* in Paleocene or older beds. The oldest species recorded is *T. acuticostata* Vaughan from the Pamunkey formation of Virginia and Maryland. The hexagonal style at the top of the columella in this species seems to place it as the possible ancestor of the American group with stellate and granular columella and of the European group with styliform, compressed or angular columella. The crenate margins of the costae connect it with *T. costata* M. E. & H. which has a compressed style at the top of the columella. This might well be considered an intermediate stage between the hexagonal style and the smooth round style of *T. sulcata* Lamarck and many other European species. The angular style of *T. forbesi* Duncan appears to have been derived from the compressed style or, possibly, from the hexagonal style. The accentuation of the angles opposite the six primary septa would develop the stellate columella from the hexagonal style. The granular columella has a noticeably hexameral arrangement that suggests a distortion of the hexagonal style or the stellate columella.

From this evidence the genus *Turbinolia* appears to have had its origin in the Tethyan sea during the interval subsequent to the deposition of Paleocene strata, near the Atlantic Coast of America where it first appeared in Lower Eocene time. From this center of distribution two distinct

groups diverged, the styliform columella group eastward to Europe and the stellate columella group westward to the Gulf Coastal Plain and California. No representative of the latter group seems to have reached the European continent, and only in the Oligocene did a member of the former group reach America.

The accompanying correlation table showing the distribution of the recorded species of the genus *Turbinolia* was compiled from the tables of Vaughan[10] and Clark[11] with changes suggested by letters from Prof. A. Morley Davies and Dr. H. G. Schenck. The divisions of the Lutetian, Calcaire Grossier, of France and the Barton beds of Great Britain were made for the purpose of giving the exact horizons recorded on the labels accompanying specimens received from Mr. Arthur Wrigley of London. This material contained topotypes of *T. sulcata* Lamarck, *T. costata* M. E. & H., *T. nystiana* M. E. & H., *T. dixoni* M. E. & H., *T. humilis* M. E. & H., *T. fredericiana* M. E. & H., and *T. exarata* Duncan. Prof. A. Morley Davies supplied the exact stratigraphical position of Milne Edwards and Haime's and Duncan's type localities. The material at hand lacks but two of their species, namely, *T. prestwichii* M. E. & H. and *T. minor* M. E. & H. Filliozat[12] records *T. dispar* Defrance and his species, *T. vaughani,* from Le Bois-Gouët, Campbon, which locality Prof. Davies says is Auversian. Milne Edwards and Haime[13] give the locality for *T. dispar* Defrance as "Eocene: Environs de Paris, Hauteville," which, according to Prof. Davies is Lutetian.

The columellar character of *T. prestwichii* M. E. & H. was indeterminable because hidden by the matrix in the only specimen ever recorded of that species.[14] The literature on the three Oligocene fossils from Germany and three of the Belgium species has not been accessible, but Duncan[15] records the former from the "Unter Oligocän" of Germany, and Mr. Wrigley writes me that *T. gerardi* Vincent is from Sables de Wemmel (Bartonian) and that *T. vincenti* Glibert and *T. nilensis* Glibert are from the Bruxellian (Lutetian). Felix[16] lists *Turbinolia octoscissa* Quenstedt from the middle Oligocene, "Osterweddigen bei Madgeburg."

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10 VAUGHAN, T. W., Spec. Publ. Bernice P. Bishop Museum No. 7, pp. 818-838, tables 1, 2, 1921; Bull. Geol. Soc. Am., Vol. 35, pp. 677-742, 1924.

11 CLARK, B. L., Bull. Geol. Soc. Am., Vol. 35, pp. 801-817, table 1.

12 FILLIOZAT, M., Bull. Soc. sc. nat. Ouest, 3e sér., t. IV, pp. 69-71, 1914.

13 MILNE EDWARDS & HAIME, Hist. nat. des. Coralliarires, Vol. 2, p. 65, 1857.

14 MILNE EDWARDS & HAIME, British Fossil Corals, Vol. 1, pp. 20-21, 1850.

15 DUNCAN, P. M., Supplement Brit. Foss. Corals, p. 56, footnote, 1866.

16 FELIX, J. Fossilium Catalogus Animalia, Pars 28, p. 169, 1925.

CORRELATION TABLE SHOWING STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION OF FOSSIL TURBINOLIAS

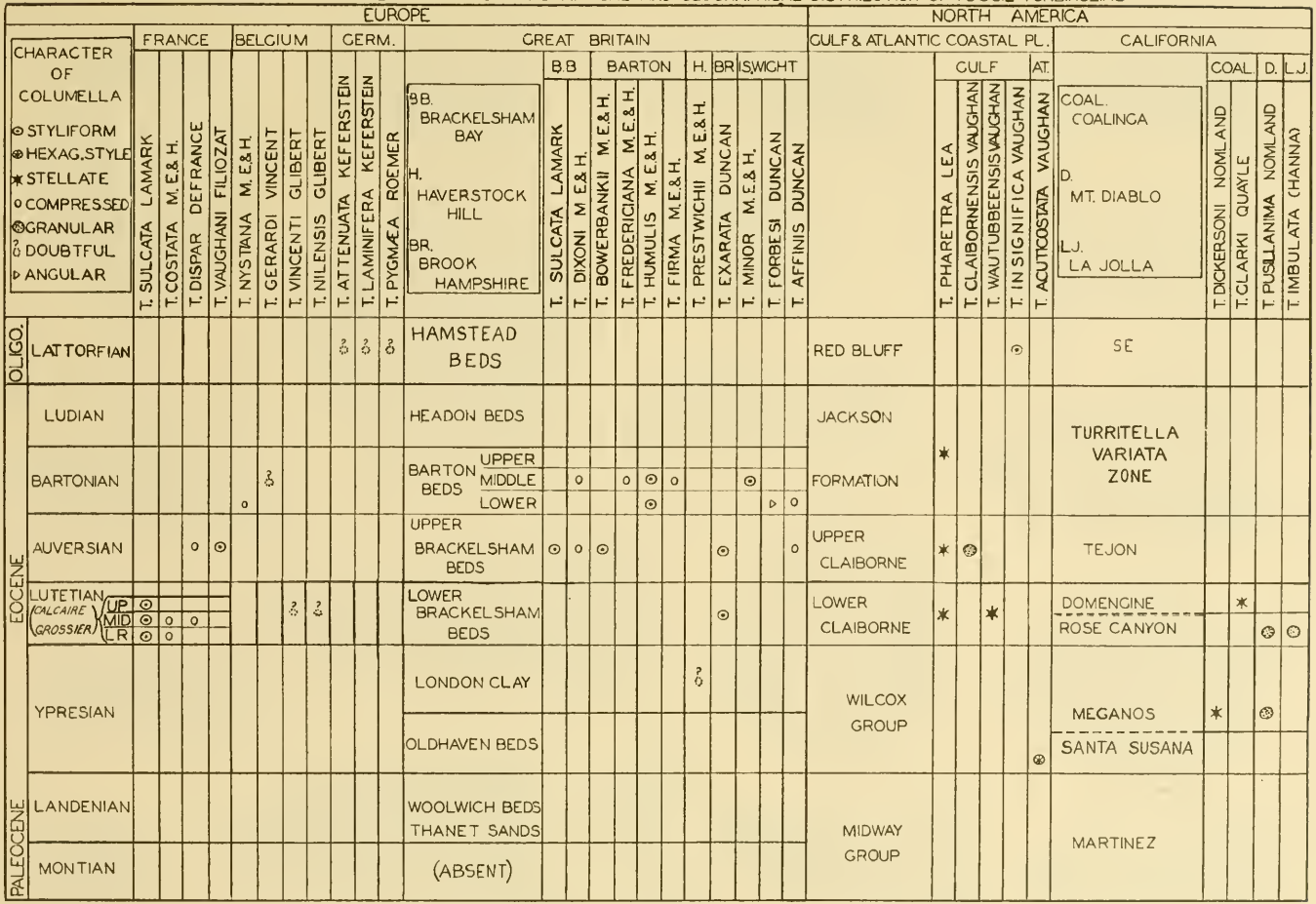


Fig. 12. Correlation Table. (Explanation of symbols in upper left-hand corner. SE indicates Sespe formation, non-marine.)

PLATE 6

Drawings by camera lucida

Line at lower right of specimen shows the natural size

Fig. 1. *Turbinolia dickersoni* Nomland
Plesiotype No. 379, S.D.S.N.H. type collection, from the type locality, U. C. locality 1817: "On branch of Salt Creek, near center of Sec. 15, T. 18 S, R. 14 E, M .D. B. & M., Fresno County, California, about 16 miles north of Coalinga."

Fig. 2. *Turbinolia dickersoni* Nomland
Plesiotype No. 381, S.D.S.N.H. type collection, from the type locality. Longitudinal section to show internal structure.

Fig. 3. *Turbinolia dickersoni* Nomland
Plesiotype No. 378, S.D.S.N.H. type collection, from the type locality. Short stout form.

Fig. 4. *Turbinolia dickersoni* Nomland
Plesiotype No. 379, S.D.S.N.H. type collection, from the type locality. View of the calice of fig. 1.

Fig. 5. *Turbinolia dickersoni* Nomland
Plesiotype No. 380, S.D.S.N.H. type collection, from the type locality. Showing pits in intercostal furrows.

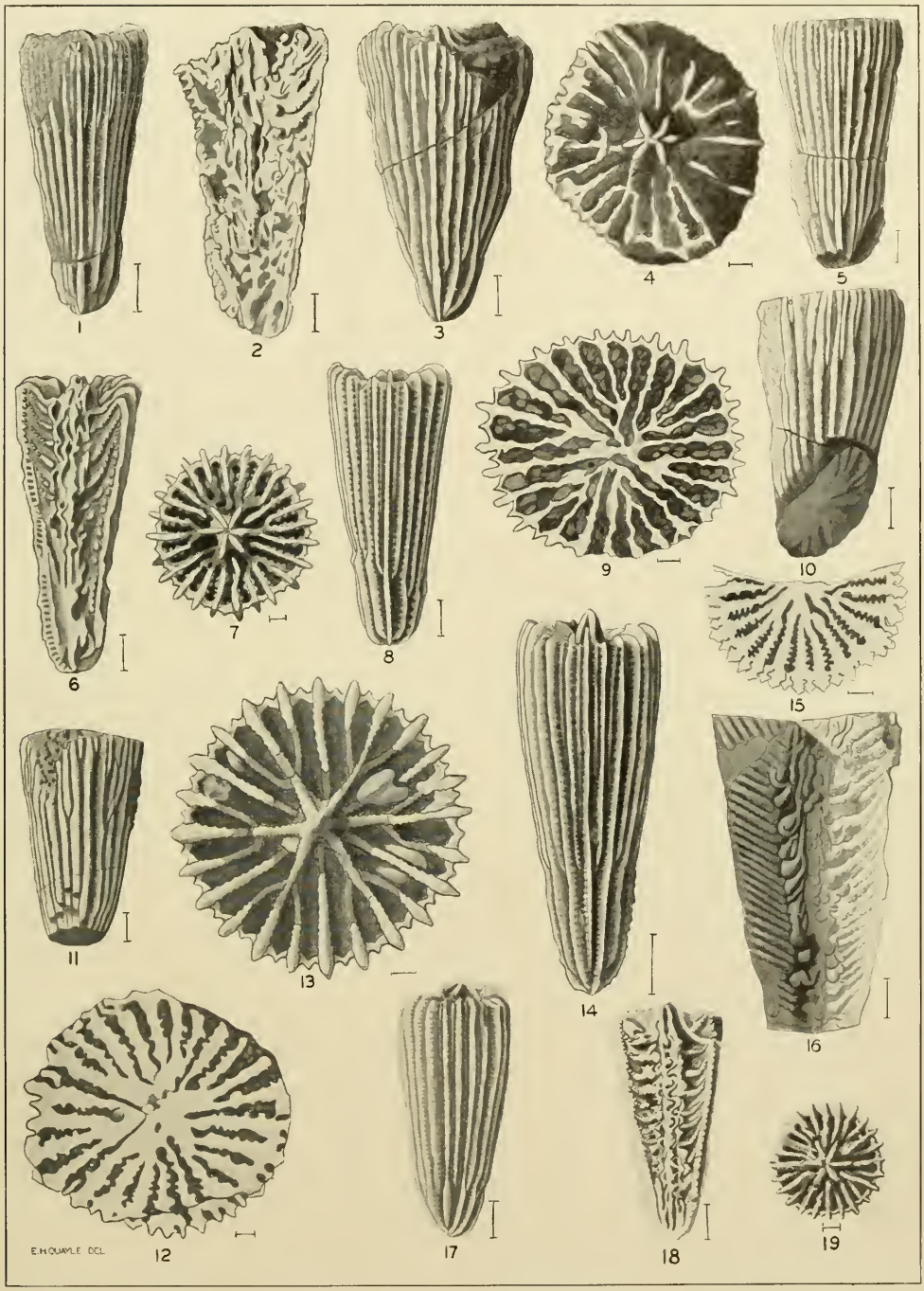
Fig. 6. *Turbinolia clarki* Quayle, sp. nov.
Syntype No. 32381, U. C. Mus. Paleo. type collection, from the type locality, U. C. locality 672: "SE$\frac{1}{4}$ of NW$\frac{1}{4}$ sec. 24, T. 18 S, R. 14 E, M. D. B. & M., Parsons Peak, 0-10 ft. below white shale. Domengine Ranch and Creek, Coalinga Quad., Fresno County, California." Longitudinal section showing internal structure.

Fig. 7. *Turbinolia clarki* Quayle, sp. nov.
Syntype No. 32380, U. C. Mus. Paleo. type collection, from U. C. locality 672. Calicular view.

Fig. 8. *Turbinolia clarki* Quayle, sp. nov.
Syntype No. 32380, U. C. Mus. Paleo. type collection, from U. C. locality 672. Upright view of corallum.

Fig. 9. *Turbinolia pusillanima* Nomland
Plesiotype No. 376, S.D.S.N.H. type collection, from the type locality, U. C. locality 476: "SW$\frac{1}{4}$ of NW$\frac{1}{4}$ sec. 22, T. 1 S, R. 1 E, M. D. B. & M., elevation 1200 feet, in little wash near creek, below 1250-foot hill. Diablo Quadrangle, Contra Costa County, California." Cross section near the calice.

(*Continued on page 109*)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EXPLANATION OF PLATE 6—(Continued)

Fig. 10. *Turbinolia pusillanima* Nomland
Plesiotype No. 376, S.D.S.N.H. type collection, from the type locality. Upright view to show costae.

Fig. 11. *Turbinolia imbulata* (Hanna)
Plesiotype No. 359, S.D.S.N.H. type collection, from "Rose Canyon." Upright view showing costae and pits in intercostal furrows.

Fig. 12. *Turbinolia imbulata* (Hanna)
Plesiotype No. 359, S.D.S.N.H. type collection, from "Rose Canyon." Cross section near the calice.

Fig. 13. *Turbinolia sulcata* Lamarck
Plesiotype No. 382, S.D.S.N.H. type collection, from "Middle calcaire grossier—Lutetian, (ferme des Boves) Parnes (Oise) France," Arthur Wrigley's label. The type locality given by Milne Edwards & Haime (1857) is "Environs de Paris." View of calice.

Fig. 14. *Turbinolia sulcata* Lamarck
Plesiotype No. 382, S.D.S.N.H. type collection. Upright view of corallum showing costal characters and pits in the intercostal furrows.

Fig. 15. *Turbinolia imbulata* (Hanna)
Plesiotype No. 358, S.D.S.N.H. type collection, from the type locality, U. C. locality 5051: "At mouth of tributary to San Clemente Creek, due west of the "s" of Pueblo Lands [La Jolla topographic sheet of the U. S. Geological Survey], 40 ft. above the bottom of the creek. Elevation 225 feet." San Diego County, California. Cross section near the calice.

Fig. 16. *Turbinolia imbulata* (Hanna)
Plesiotype No. 358, S.D.S.N.H. type collection, from the type locality. Longitudinal section showing ornamentation on the septal faces.

Fig. 17. *Turbinolia pharetra* Lea
Plesiotype No. 44251, U. S. Nat. Mus., from the type locality, Claiborne, Alabama. Upright view of corallum showing costae swollen at the base and double row of pits in the intercostal furrows.

Fig. 18. *Turbinolia pharetra* Lea
Plesiotype No. 44252, U. S. Nat. Mus., from the type locality, Claiborne, Alabama. Longitudinal section showing ornamentation on the septal faces.

Fig. 19. *Turbinolia pharetra* Lea
Plesiotype No. 44251, U. S. Nat. Mus., from the type locality, Claiborne, Alabama. View of the calice.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 11, pp. 111-118, plate 7

A RARE DEEP-SEA SCOMBROID FISH, XENOGRAMMA CARINATUM WAITE, ON THE COAST OF SOUTHERN CALIFORNIA

BY

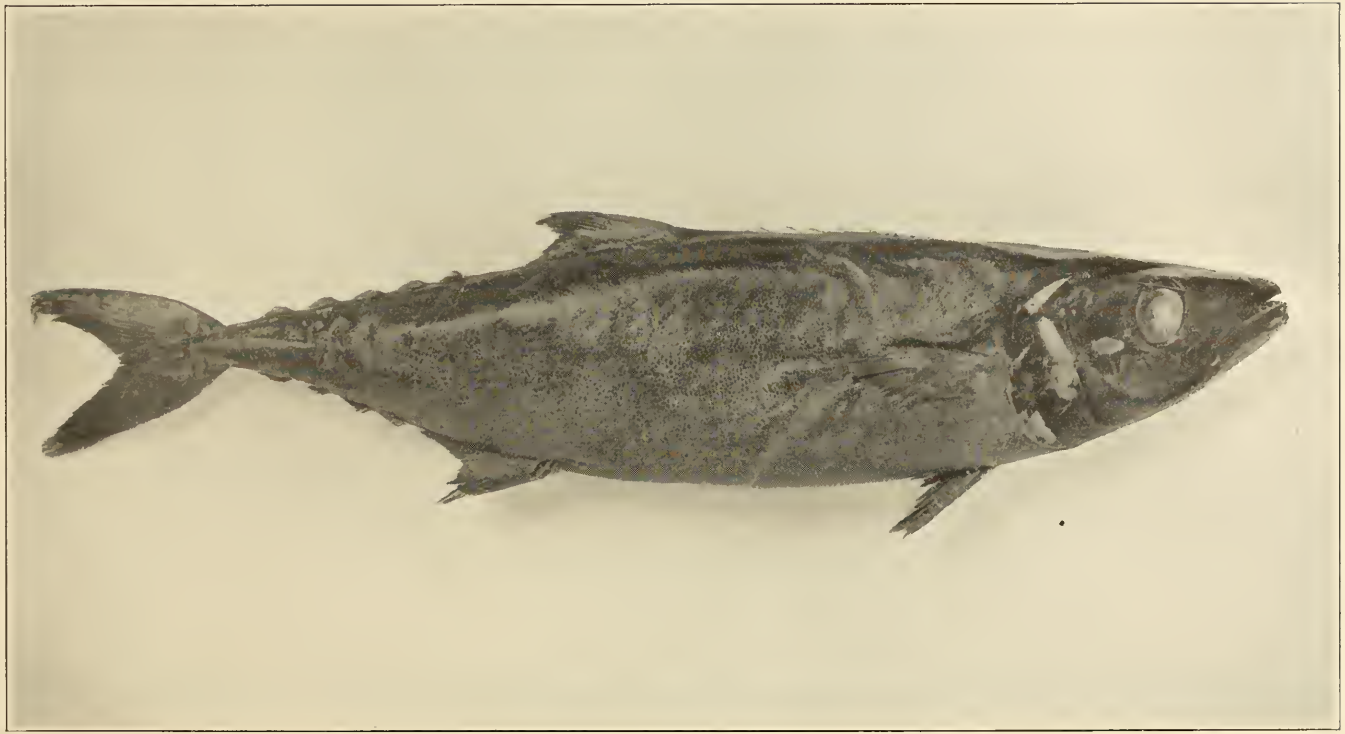
GEORGE S. MYERS

Stanford University

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

JULY 28, 1932



Xenogramma carinatum Waite. Long Beach, California.
The black skin in the opercular region has been injured and the burrow of a parasitic roundworm is visible at the origin of the anal fin.

A RARE DEEP-SEA SCOMBROID FISH, XENOGRAMMA CARINATUM WAITE, ON THE COAST OF SOUTHERN CALIFORNIA

BY

GEORGE S. MYERS

Stanford University

In the spring of 1928, Mr. Joseph Craig, then of the California State Fisheries Laboratory, San Pedro, mentioned to me that a peculiar black tuna-like fish had been found cast up on the beach at Long Beach not long before by a representative of the State Fish and Game Commission. Mr. Craig had been unable to identify the fish and he very kindly offered to have the specimen sent to me for examination and permanent preservation in the Stanford collections. Upon arrival it was at once seen that the species was one hitherto entirely unknown on the American coast. The record is so unusual that it seems best to publish the present note, together with a photograph of the specimen made through the courtesy of Mr. Lionel A. Walford and the California State Fish and Game Commission.

Xenogramma carinatum Waite

Plate 7

? *Thyrsites niger* Poey, 1875, p. 148 (p. 74 of separate), pl. 3, figs. 20, 21 (Coast near Havana, Cuba).

Xenogramma carinatum Waite, 1904, p. 157, pl. XIX, fig. 1 (Lord Howe Island).

? *Diplogonurus maderensis* di Noronha, (Apr. 10) 1926, p. 381, fig. 1 (Cama de Lobos, Madeira).

Lepidosarda retigramma Kishinouye, (May 25) 1926, p. 378, figs. 1-3 (Fukushima-Ken and Owase, Miye-Ken, Japan).

A specimen, found struggling in the surf at Long Beach, Los Angeles County, California, in 1928. Now in the collection of Stanford University, cat. no. 24797.

The measurements in millimeters are as follows: Total length 734, standard length (to end of caudal keel) 623, head 167, depth at dorsal origin 143, snout tip to origin of soft dorsal 343, snout tip to origin of anal fin 421, snout tip to origin of pelvic fin 171. Other proportional details are well shown in the photograph.

First dorsal 9, the spines set in a groove into which they may be lowered. Second dorsal 16, followed by 5 finlets. Anal 15, followed by 4 finlets. Pectoral 15, the last ray bordered below by a narrow adipose flap. Soft dorsal, anal, and pelvics thickly covered, nearly to their tips, with fine elongate scales. Pectorals and caudal thinly covered nearly to their tips with very fine scales.

Tail with a strong lateral keel on each side formed of many laminated horny sections. Above and below the end of the large keel, on each side, there are two low, fleshy, supplementary keels, converging and disappearing toward the center of the caudal fin.

Scales of body peculiar, irregular both in shape and arrangement. Each larger scale is surrounded and separated from its fellows by a narrow area of integument in which are imbedded small scales many of which appear to be perforated by sensory pores. The general effect is that of a mosaic of large darkly colored scales separated by a network of narrow light lines, the lines being pierced by many small pores. The scales vary in size on various parts of the body, being much larger and more irregular behind the lower part of the opercle (below pectoral base), behind the post-temporal region and above the anal base. The scales run forward on the nape to above the angle of the preopercle. The cheeks, from a little behind the end of the maxillary, the postorbital region, the preopercles, interopercles, subopercles, and opercles, are closely covered with thin scales. The skin covering the maxillary, premaxillary, and dentary is covered with fine diverging striations.

The lateral line is most remarkable. It is very faint and extremely difficult to trace. It apparently begins by the union of two short, forward-projecting branches above the upper end of the gill slit, thence running backward along the upper part of the sides until below the seventh or eighth dorsal spine. Here it makes a great sweep directly downward to near the ventral side of the body, turns, runs backward to a little past the origin of the soft dorsal, thence upward in a point to the midline of the sides below the posterior part of the soft dorsal. It immediately runs down again in a great curve above the anal fin, not dipping so long or low as the first time, thence up to above the midline, whence, after a short curve downward, it enters the anterior end of the large caudal keel. The path of the lateral line, which does not show in the photograph, is well figured by Waite.

Eyelid strong, the orbit vertically elongated. Teeth on dentary in a single series, enlarged and somewhat curved backward. Teeth in premaxillary much smaller, the two front teeth somewhat enlarged. Behind the first series there are, in the front, four fang-like teeth as large as those of the dentary. A half-circle of widely spaced vomerine teeth and a single long series of small teeth down each palatine. Gills 4, the rakers practically absent, the arches having only fine asperities on their forward sides. Pseudobranchiae very well developed. Opercle with a distinct notch above, this being hidden by skin.

Color dark brown, the head and fins, with the exception of the pectorals and the finlets, blackish.

The fish is extremely oily, the oil oozing out and covering the surface of the alcohol in the jar in which the specimen is kept.

DISCUSSION OF SYNONYMY AND RELATIONSHIPS

Poey's *Thyrsites niger* was described in 1875 from a section of the caudal peduncle of a fish of 100 pounds weight, cast up on the Cuban coast near Havana. Poey mentions that spiny scales such as those of *Ruvettus* were not found on the skin and he gives an outline sketch of one rounded cycloid scale, but he does not mention the peculiar arrangement of the squamation of *Xenogramma*. He notes, however, that the fish had a peduncular keel on each side, that the color was black and that the fish was similar to *Ruvettus* in the oily quality of the flesh. Until further material is obtained in the Caribbean it seems best to question the identity of Poey's fragment with *Xenogramma*.

Waite described his *Xenogramma carinatum* in 1904 from a single 575 mm. specimen cast up alive at Lord Howe Island, east of New South Wales. No one seems to have reported finding the species since that date. There is in my mind no doubt that the California specimen is the same species, despite some minor discrepancies. I find no gill rakers, while Waite mentions a few weak spines near the angles of the arches. His specimen had 6 finlets above and 5 below, mine one less in each case. His count of 16 dorsal finlets in the description is an obvious misprint as his figure plainly shows 6. Waite considered the possibility of the identity of his fish with Poey's, but expressed the view that the Cuban fish was still insufficiently known.

Di Noronha's account of *Diplogonurus maderensis* appeared in April, 1926. Although his description is incomplete in many important points, he gives details of the peculiar scales which agree only with those of *Xenogramma* among known genera. The description of other parts allows a suspicion that the article, which was translated and published without correction by the author, may have suffered at the hands of translator or editor. "Mouth not reaching front margin of eye" and "extremity of pre-maxillary not reaching to opposite middle of orbit" scarcely agree. Further, "anterior nostril oval, back of a vertical slit," may have been, "anterior nostril oval, back one a vertical slit," in which case it agrees admirably with *Xenogramma*. The statement that the first dorsal has a long base continuous with the second, which is opposed to the anal does not agree with *Xenogramma,* but so many of the other described characters are identical that I cannot help thinking that di Noronha's fish may be the same as mine. It is said that *Diplogonurus* ("Escolar de Natura") is caught at a greater depth than *Ruvettus* (the

"common Escolar"), commonly at a depth of 800 yards (400 fathoms). It attains a weight of 30 kilograms or more, and has oily flesh which, like that of *Ruvettus,* is extremely laxative. No type specimen of *Diplogonurus* was ever sent to the Carnegie Museum by di Noronha.

A little more than a month after di Noronha's description appeared, Kishinouye described *Lepidosarda retigramma,* from deep water off the Pacific coast of Hondo. He referred it to his family Cybiidae and remarked on the oiliness and laxative effect of its flesh. The external characters are described briefly and the skeleton, musculature and viscera with some detail. Kishinouye overlooked the faint lateral line, but the other characters in his description and figures leave no doubt that he had *Xenogramma.*

This completes the history of this fish insofar as the literature at hand permits. Apparently the various nominal forms listed in the synonymy have never been reported in ichthyological literature other than in their original descriptions, and none has ever been definitely synonymized.

Waite referred *Xenogramma* to the Gempylidae without comment. Di Noronha, while recognizing the affinity of *Diplogonurus* to the Gempylidae, erected a new family, Diplogonuridae, for its reception. Kishinouye, while he compared the appearance of his *Lepidosarda* to *Ruvettus,* seems not to have considered its relationship to the Gempylids. He places it in his family Cybiidae, although he remarks that it is not wholly typical of the group. In his account of the skeleton he omits mention of the basal parts of the caudal rays, wherein lies the principal diagnostic character of the Gempyloid group.

It seems to me that the great similarity of *Xenogramma* to *Ruvettus,* in appearance, external structural details, oily flesh, and habits, should not be overlooked, and for the present I prefer to place it in the Gempylidae not far from *Ruvettus.*

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VOLUME VII, No. 12, pp. 119-150, plates 8, 9, map

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THE AVIFAUNA OF TIBURON ISLAND, SONORA, MEXICO, WITH DESCRIPTIONS OF FOUR NEW RACES

BY

A. J. VAN ROSSEM

California Institute of Technology

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

JULY 28, 1932

Publications of the San Diego Society of Natural History

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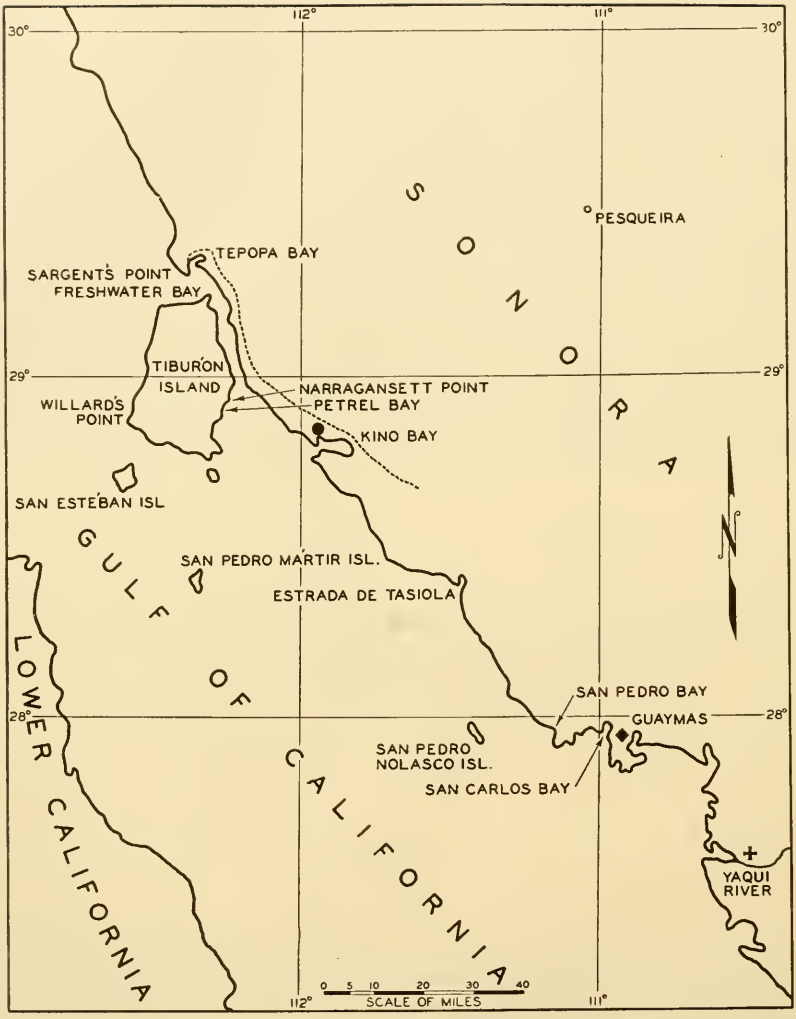

TIBURON ISLAND AND NEIGHBORING REGIONS

The northern known limits, coastwise, of various Alamos District races are as indicated:

● *Auriparus flaviceps fraterculus, Heleodytes brunneicapillus brunneicapillus, Richmondena cardinalis affinis.*

◆ *Pipilo fuscus intermedius.*

✚ *Lophortyx gambelii fulvipectus, Toxostoma curvirostre maculatum.*

The mainland coast within the double line is in the Arid Tropical Zone, which extends for an unknown distance inland. The extreme northern limit of this zone coastwise is, as shown on this map, at Tepopa Bay just above the northern end of Tiburón Island.

THE AVIFAUNA OF TIBURON ISLAND, SONORA, MEXICO, WITH DESCRIPTIONS OF FOUR NEW RACES

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Tiburón, largest of the many islands lying within the Gulf of California, is, curiously enough, one of those whose bird life is relatively unknown. Though the reputed hostility of the formerly numerous inhabitants, the Seri Indians, has undoubtedly been a factor in causing the average pleasure or fishing party to give the island a wide berth, nevertheless a number of well equipped expeditions have from time to time entered the waters of the Gulf of California and several of these have investigated the island's botany, mammalogy, and herpetology. However, from one cause or another, the fact is that Tiburón has remained, so far as its bird life is concerned, "terra incognita" up to recent years. Of the many naturalists who have visited this general vicinity I know of but three who have attempted to do any ornithological work previous to the visit of our own party in the closing days of 1931.

In the history of the island the first species of bird of which I have been able to find mention is Brewster's Booby, a specimen of which Dr. Thomas Streets collected in April, 1875, when he was on board the United States surveying steamer "Narragansett." Since the collector says that the bird (which he called *Sula leucogaster*) was taken with its two eggs it follows that a landing was made, though more probably one of the several detached rocks rather than the main island was the actual locality. From April 11 to 13, 1911, the famous steamer "Albatross" of the United States Bureau of Fisheries was at Tiburón and during this short time the naturalists on board, under the direction of Dr. Charles H. Townsend, collected or observed thirty-two species of birds, one of which, a brown towhee, was subsequently described as new. Dr. Townsend's report was published in 1923, in Volume 48 of the Bulletin of the American Museum of Natural History. Even though this list contained a large percentage of widely distributed sea and land birds as well as some migrants, it nevertheless provided the first indications as to the affinities of the avifauna. The next visit of record was when a party of egg collectors

headed by Griffing Bancroft landed on May 22, 1930, at which time something less than a dozen species of land birds were collected, of which all but three had been recorded previously by Dr. Townsend. Mr. A. W. Anthony was at Tiburón on December 5, 1930, but was unable to do any collecting. However, he has kindly furnished me with a list of the water birds he noted at that time. The present writer, one of the members of a party on board Mr. J. R. Pemberton's yacht "Petrel," had the good fortune to spend the greater part of five days from December 28, 1931, to January 1, 1932, on the island. Thanks to the assistance of Mr. Pemberton I was able to collect or record seventy-two species, bringing the known total to eighty-two.

Our time on the island was divided as follows. The late afternoon of December 28, and all day December 29, were spent on the east side just south of Narragansett Point at the site of an old Indian encampment. This place is marked on charts "Indian huts. Fresh water," but for purposes of brevity it will be here referred to as Petrel Bay. December 30 and 31 we were anchored about the center of the south end, and January 1 was spent in cruising up the west coast with a stop in the late afternoon at Freshwater Bay at the extreme north end of the island.

While many additional species unquestionably will be found when some one who is competent to do so has occasion to make a visit during the breeding season, it is doubtful if many more permanent residents will be discovered. I make this prediction because of the definitely limited number of associations present, a condition usual to desert areas, and it was only in the alluvial washes that we found vegetation in sufficient quantity to provide shelter for birds other than semi-rupestrine species such as the Rock Wren. There is probably surface water present in small quantities, indeed there are undoubtedly springs from which the Indians obtained a supply, but these we failed to find and to all appearances and for a large proportion of the land bird population the island is a waterless one. As in most desert areas we found birds to be uncommon not only as to species but as individuals, so much so in fact, that we obtained only seventy-three specimens in five days. The above statement as to scarcity excepts, however, several winter visitants such as the Green-tailed Towhee, Lark Bunting, and Gambel's and Brewer's Sparrows, all of which were irritatingly numerous and interfered to some extent with the detection of the more interesting residents.

The location of Tiburón is on the 29th degree of north latitude and

very close to the Sonora shore; indeed it is an island only by virtue of a narrow, shallow strait only a mile wide at its narrowest point. In size the island is twenty-nine miles long and averages about fifteen miles in width. The terrain is exceedingly rough and broken and rises in most places directly from the shore in a series of fantastically outlined ridges and peaks to a trifle less than 4000 feet in the central parts. It is almost entirely volcanic in origin just as are the Seri Mountains on the opposite mainland. From a distance off shore the island appears to be nearly or quite barren of vegetation, but on a closer approach one perceives that the alluvial washes are fairly well grown with low scrub. The hills retain their barren appearance for they support only a thin growth of grass where a little soil has accumulated on the older lava flows and with here and there a scattering of thin, desert vegetation.

So far as we were able to determine at the present time Tiburón is much more closely allied to the Colorado Desert District of the Lower Sonoran Zone than to the Alamos District of the Arid Tropical, even though on the mainland littoral the actual border line between the two lies at or very near a point opposite the northern end of the island. The influence of the Arid Tropical is evident on the island only through the presence of such tree growth as *Lysiloma candida* which, although it is not an uncommon tree in the washes on the east side of the island near Narragansett Point, has not previously been reported from here, *Acacia willardiana* and *Jaquinia pungens*. Also here and there near tide water are thickets of low and extremely thorny scrub of a species which grows abundantly on the Tropical Zone coastal plain, but which I have not, as yet, been able to identify by name. Palms and other growth which form so prominent a part of the typical Tropical landscape are seemingly absent. By far the most pronounced floral features are the Lower Sonoran ocotillo (*Fouquieria splendens*), creosote (*Larrea*), several species of *Atriplex, Opuntia bigelovii,* and the giant cactuses (*Carnegiea gigantea, Pachycereus pringlei,* and *Lemaireocereus thurburi*). The generally distributed mesquite (*Prosopis chilensis*), palo verde (*Cercidium*), and copal (*Elaphrium*) are also common. The observations of Ivan Johnston, the botanist who accompanied the 1921 California Academy of Sciences expedition, accord very closely with our own and his determination of the dividing line between Arid Tropical and Lower Sonoran Zones, which was based on the flora, corresponds so exactly with our own which was based almost entirely on the birds, that I quote some short extracts from his report in the Proceedings of the California Academy of Sciences for

1924. "Very roughly, it may be said that the floristic break in the Gulf area occurs at about 29° 30′ North latitude. A nearly typical Colorado Desert landscape and flora were found on the Sonoran coast at Tepoca Bay. The same flora occurs in a diluted form on the north end of Tiburón Island. The range of hills which extends along the coast north of Guaymas seems to contain much of the Guaymas [i.e. Arid Tropical] flora which also reappears very diluted on the south end of Tiburón Island." Just what the author means by "diluted" is slightly ambiguous, that is, it is not clear whether he means a reduction in the number of species or whether there is a mixture from the two zones. From personal observation both interpretations are true, although the vegetation is slightly less typical of the desert type at the south end. Unquestionably Tiburón possesses a less luxuriant, a less varied, and a more typically Sonoran flora than does the opposite mainland whose littoral, together with the contiguous strip of coastal plain, is definitely within the Arid Tropical Zone. That this zonal distinction between island and adjacent mainland is due to a climatic and not to a soil difference is to be inferred from the fact that the island is, geologically, simply a fortuitously separated part of the mainland and therefore possesses essentially the same type of soil. Furthermore the mainland shore north as far as Tepopa Bay supports here and there along tide water an occasional clump of mangroves, of all littoral plants the most certain indicator of the Tropical Zone. This plant, so far as we could discover, is not present on the island, even on the sheltered southern and southeastern shores.

A consideration of the avifauna must be confined to those which may properly be considered to be index species. In the present case seventy out of the eighty-two known species may be eliminated as having no bearing on the question. These consist of sea birds, land birds of general distribution, and transients. I mean by index species those the *local* distribution of whose races is coincident with definable faunal areas in the region under consideration. One illustration will suffice. A subspecies of woodpecker, *Centurus uropygialis uropygialis* is, on the coast of Sonora, characteristic of the Colorado Desert District of the Lower Sonoran Zone, while another race, *Centurus uropygialis sulfuriventer,* is characteristic of the Alamos District of the Arid Tropical Zone immediately to the south of the Colorado Desert District. The presence of the desert race, *uropygialis*, on Tiburón will, then, indicate in part that the faunal relationships of the island area are with the northern and not with the southern district. On the other hand, shrikes of the subspecies *Lanius ludovicianus*

sonoriensis are confined in Sonora to no particular district, but extend north and south of Tiburón for many hundreds of miles. Their presence on Tiburón is, therefore, without significance in the determination of the faunal relationships of the island and it is ignored in that connection. But in another area, say in northeastern Lower California, this same shrike would very properly be used as an index subspecies because there its distribution is definitely coincident with the Colorado Desert District. On this basis then it is clear that five of the forms to be found on Tiburón Island at the present time have come from the Colorado Desert District, one has come from the Alamos District, and six are endemic.

The five Colorado Desert District subspecies, *Colaptes chrysoides mearnsi, Centurus uropygialis uropygialis, Dryobates scalaris cactophilus, Myiarchus cinerascens cinerascens,* and *Carpodacus mexicanus frontalis,* are all forms to which the mile wide strait presents scarcely any inconvenience, certainly not a barrier, and it is safe to assume a continual interchange of populations between island and mainland, where, in each case, the same races are to be found. The single Alamos representative is *Auriparus flaviceps fraterculus.* The six endemic races, *Lophortyx gambelii pembertoni, Heleodytes brunneicapillus seri, Toxostoma curvirostre insularum, Polioptila melanura curtata, Richmondena cardinalis townsendi,* and *Pipilo fuscus jamesi,* are separated from the mainland by a mile of water which has proved to be a barrier sufficient to isolate effectively the island colonies. Any one of the six could pass this barrier, but the fact is that they have not done so.

Critical examination of the insular races discloses a most surprising condition and one for which at first there seemed to be no solution. However, after careful study of the situation I am convinced that the data at hand provide evidence that a decided change in the climate of the central Sonora coast with a consequent southward recession of certain Tropical races has taken place at some time since the establishment of the six endemic races on Tiburón Island. The facts are as follows. Five out of the six races possess essentially the size, proportions, and markings of the corresponding Alamos (Tropical Zone) representatives and do not agree in any of these particulars with the Colorado Desert subspecies even though, in some cases, these latter now are found on the adjacent mainland shore. To consider the island and the mainland forms individually we find that the Tropical Zone cactus wren and cardinal extend northward at the present time along a narrow strip of coast to a point opposite the

island. No brown towhee is known to occur anywhere along the coast closer than Guaymas, a distance of about one hundred miles to the south. The Tropical Zone Gambel's quail and thrasher do not approach closer than the lower Yaqui River Valley nearly one hundred and fifty miles away; while on the mainland opposite the island the two respective Colorado Desert races occur, races with which the island birds have nothing in common other than specific consanguinity. As just stated and here re-emphasized, the agreement of the five island birds under immediate consideration is with the Tropical Zone races in size, proportions, and markings. Their chief difference lies in that each, instead of being relatively deeply or richly colored, possesses a pallid, ash-gray coloration. If the hypothesis that the endemic Tiburón races are of Tropical Zone ancestry be accepted, and with the evidence at hand I do not see how we can escape so doing, it follows that environmental conditions have caused a withdrawal southward of Tropical Zone races from the mainland at the latitude of the island to distances up to one hundred and fifty miles. Whether these recessions were actual withdrawals or whether the Tropical stock was gradually bred out by repeated invasions as the desert races moved south, we have, of course, no means of determining. In the case of the towhee the withdrawal has evidently been an actual one; the characters shown by thrashers and quail over a large area of territory suggest a replacement. The withdrawal of Tropical races and invasion of Sonoran desert ones indicates that the change has been in the direction of aridity.

The local race of black-tailed gnatcatcher demands different consideration, in that this species, although it has penetrated southward as far as Guaymas and thus well into the Tropical Zone, has no Tropical representative on the mainland and there is no reason to question a relatively recent extension of range contemporaneously with the northern race of Gambel's quail and the thrasher. For how long it has been isolated on Tiburón we have no means of knowing certainly, but supposedly it arrived at the same time as the other Colorado Desert forms now found there. At any rate it is the only sedentary bird of Colorado Desert relationships so far found on the island. The distinctive characters which this isolated colony has developed show no correlation in color with those of Tropical derivation, since in this case slightly darker and browner coloration is shown by comparison with mainland birds.

SUMMARY

1. Tiburón Island, though separated from the definitely Arid Tropical mainland only by a narrow strait varying from one to three miles in width, nevertheless possesses features which place it within the Lower Sonoran rather than in the Arid Tropical Zone.

2. Its present day avifauna is a heterogeneous one made up of five representatives of the Colorado Desert District, one of the Alamos District, and six endemic races, besides seventy others of general desert or maritime distribution.

3. In the cases of six species of birds, all of which are relatively sedentary, one mile of water has proved to be a barrier sufficiently effective to prevent an interchange of populations with opposite sides of the strait.

4. Five of the six species thus isolated most nearly resemble in size, proportions, and markings races representative of the Alamos District and we may therefore conclude that their derivation has been from Arid Tropical and not from Lower Sonoran stock. The sixth is clearly of Lower Sonoran (Colorado Desert) ancestry.

5. Some of the Alamos races, from which five of the endemic Tiburón forms presumably have developed, still occupy the opposite mainland, others have retreated southward for distances of up to one hundred and fifty miles and their former northern territory has been occupied by southward invasions of Colorado Desert forms. This shift in populations has most probably been in response to an increasing aridity of climate which has made the central Sonora coast more suitable for desert races and less suitable for tropical ones.

6. Though isolated for an unknown length of time in an increasingly arid Sonoran environment, four of the five races of probable Tropical ancestry have shown to date no perceptible change in size, proportions, or markings, while the fifth has become reduced in size. However, all have developed, to a degree unequalled in any other races of these species regardless of their environment, a pallid, ash-gray coloration. The single local race of Sonoran antecedents has undergone, like one of the Tropical descendants, a reduction in size, but has developed a slightly browner, *darker* coloration. The apparent anomaly of diverse trends in coloration when various species are isolated under identical conditions is found actually to accord perfectly with the generalities frequently expressed as to the color tendencies of climatic varieties, since five relatively deeply colored

Tropical Zone birds have, when isolated in a Sonoran habitat, become to an extreme degree pale and gray, and a Sonoran desert race under conditions showing a slight approach toward the Tropical has become more deeply colored.

My own interpretation of the evidence is that the action of a change of climate has induced the color changes apparent in the endemic Tiburón Island birds, and that isolation has been a factor in so far as it has acted as an insulator. Not only is it possible to observe the directions the trends have taken, but also the distance covered since in each case we are able with reasonable certainty to point to the forms from which they were derived.

Annotated List of the Species, Including Descriptions of New Forms

Gavia immer subsp.?

Loons of this species were rather common in the large area of quiet water between the southeastern side of the island and the mainland. On December 28 several, which were so gorged that they could neither dive nor fly, were noted and one of these we pursued for over a mile. Although the speed of the boat was in excess of eight knots, this bird had no difficulty in keeping up the pace, in fact at the end of the chase when we finally gave up the loon had nearly doubled the gap between itself and the boat.

Gavia arctica pacifica (Lawrence).

Dr. Townsend records a specimen of the Pacific Loon as taken at Tiburón on April 11, 1911, at which time he found it to be "abundant." At the time of our visit the species was fairly common at sea all about the island.

Gavia stellata (Pontoppidan).

While at anchor at Freshwater Bay at the northern end of the island the evening of January 1, a Red-throated Loon was seen floating dead near the boat. The next day another dead bird was seen near Sargent's Point in Tepopa Bay.

Colymbus nigricollis californicus (Heermann).

Eared Grebes were common all about the island, particularly in the

quieter stretches of water. That the species is of general winter distribution throughout this section of the Gulf is indicated by the following supplementary records: Guaymas, December 23, 1931; San Carlos Bay, December 24, 1931; San Pedro Bay, December 25, 1931; Kino Bay, December 27, 1931; Tepopa Bay, January 2, 1932; San Estéban Island, January 11, 1932.

Phaëthon aethereus mesonauta Peters.

A single Red-billed Tropic Bird was seen by Mr. Pemberton and the writer as we were sailing close inshore along the west side of the island on January 1.

Pelecanus occidentalis californicus Ridgway.

Pelicans were common at every point touched by the "Petrel" in the Gulf. At Tiburón Island most of those seen were young birds of the previous year. The colony on San Pedro Nolasco Island, probably the largest one in the Gulf, was for the most part engaged in nest building at the time of our visit on December 25.

Sula nebouxii Milne-Edwards.

The Blue-footed Booby is not nearly as common a bird in the Gulf as is the next species. Nevertheless a few were seen daily at Tiburón at the time of our visit. Anthony (MS) notes them as "common" there on December 5, 1930. Other Sonora records made by us are Guaymas, December 24, 1931; San Pedro Nolasco Island, December 25, 1931, where breeding on this date; San Pedro Mártir Island, January 13, 1932. Anthony (MS) contributes Estrada de Tasiola, December 4, 1930.

Sula brewsteri Goss.

About Tiburón, as indeed nearly everywhere in Gulf waters, Brewster's Booby is the commoner of the two species. Streets records a breeding specimen from the island in April, 1875. We found the bird common there from December 28, 1931, to January 1, 1932, as did Anthony (MS) on December 5, 1930.

Phalacrocorax auritus albociliatus Ridgway.

Farallon Cormorants are nowhere common in the Gulf, but a few are to be found about most of the islands and at some mainland points. Both Pemberton and myself saw occasional individuals about the island

from December 28, 1931, to January 1, 1932. A single bird was also seen in the mangroves at San Carlos Bay on the Sonora coast December 24.

Phalacrocorax penicillatus (Brandt).

Observed by us along the west side of Tiburón on January 1, 1932. Brandt's Cormorant is evidently more common on the Lower California side of the Gulf, at least at this season of the year.

Fregata magnificens Mathews.

Frequently noted at the island. Although common throughout the Gulf and observed at every locality visited, I know of no breeding station nearer than Magdalena Bay on the Pacific side of Lower California.

Ardea herodias treganzai Court.

Great Blue Herons which were seen at intervals along the cliffs on the west side of the island on January 1, were in all probability this race.

Egretta thula brewsteri Thayer and Bangs.

Snowy Egrets were noted at the anchorage on the southeast side of the island December 29 and at Freshwater Bay on January 1. Dr. Townsend records a specimen as taken on April 10, 1911, though more probably it was actually taken one or two days later, since according to the itinerary the "Albatross" did not reach Tiburón until April 11.

Florida caerulea subsp.?

A single parti-colored bird of this species was seen at Petrel Bay on the afternoon of December 28. In the absence of suitable situations it is doubtful if either this species or the last mentioned breeds on the island.

Nyroca affinis (Eyton).

The Lesser Scaup Duck is a fairly common winter visitant all along the Sonora coast. Besides the dozen or more which we saw daily at the island, we found this duck in numbers at San Carlos Bay, San Pedro Bay, and Guaymas.

Melanitta perspicillata (Linnaeus).

Numerous Surf Scoters were seen about the island, usually as a single, pair, or trio of dull colored birds accompanied by a highly plumaged old

male. Although well known to be a common winter visitant to the northern part of the Gulf, specific Sonora records appear to be lacking. We found fair numbers at San Pedro Bay (specimen taken December 25), San Carlos Bay, Kino Bay, Tepopa Bay, and San Estéban Island.

Mergus serrator Linnaeus.

A common species about the island where we saw many individuals and small flocks daily. Townsend found Red-breasted Mergansers at Tiburón as late as April 11, but he makes no comment on their numbers at that season. It is apparent that the main wintering grounds are in the protected bays along the coast rather than about the islands, for we found far greater numbers at Guaymas, and at San Pedro, San Carlos, Kino, and Tepopa Bays than anywhere off shore.

Cathartes aura septentrionalis Wied.

A Turkey Vulture, possibly the same individual, was seen at Petrel Bay on December 29 and at the south end of the island on December 31.

Accipiter cooperii mexicanus Swainson.

A Cooper's Hawk, most probably only a transient in the locality, was seen in the thickets at Petrel Bay on December 28. Reasons advanced for the recognition of this race are set forth in a previous publication (Trans. San Diego Soc. Nat. Hist., 6, no. 19, 1931, 242).

Buteo borealis calurus Cassin.

Pairs of Red-tailed Hawks not infrequently were seen soaring over the hills at Petrel Bay on December 28 and 29, and a single adult was noted at Freshwater Bay on January 1.

Circus hudsonius (Linnaeus).

A single Marsh Hawk was seen beating over the *Salicornia* marsh at the south end of the island on December 31. This species is sparsely but generally distributed in winter along the Sonora coast and islands for we also noted single birds at San Carlos, San Pedro, Kino, and Tepopa Bays, and at San Estéban Island.

Pandion haliaëtus carolinensis (Gmelin).

An Osprey was seen on a nest near Willard's Point on January 1,

and others were noted at frequent intervals along the coast.

Falco peregrinus anatum Bonaparte.

Duck Hawks were noted at the south end of the island on December 30.

Falco sparverius subsp.?

Although some half-dozen Sparrow Hawks were observed at one time or another none of us succeeded in taking a specimen. Those seen may have been either the race *phalaena* which is resident on the neighboring mainland or the migratory *sparverius* which occurs in winter over the same region.

Lophortyx gambelii pembertoni subsp. nov.

Type.—Female adult; no. 50,258, collection of California Institute of Technology; mesquite thickets at Petrel Bay, just south of Narragansett Point on the east side of Tiburón Island, Sonora, Mexico, December 29, 1931; collected by A. J. van Rossem; original no. 13,921.

Subspecific characters.—Resembles *Lophortyx gambelii fulvipectus* (Nelson) of southern Sonora in the relative sharpness and blackness of the streaking on the nape and hind neck and in the strongly rufous pileum of the females; but differs remarkably from any known race of this species in the pallor and grayness of the entire dorsal coloration. In this latter respect *fulvipectus* is, in relatively fresh winter plumage, between "deep grayish olive" and "hair brown," *Lophortyx gambelii gambelii* Gambel is "mouse gray," and *pembertoni* between "neutral gray" and "light neutral gray" on the anterior part of the dorsal region.

Range.—Tiburón Island, Sonora, Mexico.

Remarks.—The Colorado Desert race, *gambelii,* ranges south, coastwise, to the neighborhood of Guaymas, at which point it commences to intergrade with *fulvipectus* of the Alamos District. However, for reasons given in the introduction to this paper, as well as in details of markings as specified above, the relationships of the Tiburón race are obviously with *fulvipectus* rather than with *gambelii.*

Although this bird was an object of especial search only one male and three females were collected. Three were taken in the growth in the alluvial washes at Petrel Bay while the fourth was shot in rather open, desert country at the south end of the island. Perhaps twenty birds were seen all told which, with the exception of a single pair in the more open south end desert, were in two flocks of eight or ten each in the mesquite thickets at the first mentioned place.

In naming this race for Mr. J. R. Pemberton I am actuated not only by the fact that his cooperation resulted in a very interesting and enjoyable visit to Gulf waters, but because of the very material assistance he gave me in the work on Tiburón.

Haematopus palliatus frazari Brewster.

We saw several pairs of Frazar's Oyster-catchers at various points about the island. Even at this midwinter season courting was in progress. The species is generally distributed along the Sonora coast and appears to be as common as on the Lower California side of the Gulf. We saw them at San Pedro, San Carlos, Kino, and Tepopa Bays, and at San Estéban Island.

Charadrius nivosus nivosus (Cassin).

A single pair, one of which was collected, was found on the beach at Petrel Bay on December 28.

Charadrius semipalmatus Bonaparte.

Recorded by Townsend, who lists two specimens taken at Tiburón on April 12, 1911.

Pagolla wilsonia beldingi Ridgway.

Belding's Plovers were not common on Tiburón, although five (one of which was collected) were seen on the beach at the south end on December 31 and another flock of at least twenty was noted at Freshwater Bay on the evening of January 1. This plover is generally distributed all along the Sonora coast and off-shore islands and was noted in greater or lesser numbers at every point touched.

Aphriza virgata (Gmelin).

Known only from the record of Townsend who took one or more specimens on April 12, 1911.

Arenaria melanocephala (Vigors).

Townsend lists five specimens as taken on April 12, 1911. Mr. Glassell, a member of our party, saw two turnstones on a rocky reef at the south end of the island on December 31, which he believed to be of this species.

Actitis macularia (Linnaeus).

Spotted Sandpipers were noted by us as fairly common. Anthony (MS) saw "a few" on December 5, 1930.

Catoptrophorus semipalmatus inornatus (Brewster).

The Western Willet was observed in numbers at various places along

the island shores. It is also common throughout the Gulf at this season for it was found at every locality touched by us. Specific Sonora records are Guaymas, San Pedro, San Carlos, Kino, and Tepopa Bays, and San Pedro Nolasco and San Estéban Islands.

Larus occidentalis livens Dwight.

A common species everywhere about the island. Other localities at which this very common gull was noted are too numerous to mention save that it was found at every stop and at intermediate points throughout the Gulf.

Larus argentatus smithsonianus Coues.

A single Herring Gull was taken at Petrel Bay on the afternoon of December 28.

Larus californicus Lawrence.

This is perhaps the most common non-resident gull to be found in the Gulf area during the winter months. In addition to the numerous small flocks which we saw daily at Tiburón, we found it to be common at every other Sonora locality touched, both coastwise and insular.

Larus delawarensis Ord.

Although present in somewhat fewer numbers than the last named species the Ring-billed Gull was found to be common not only at Tiburón, but at every other place visited. Anthony (MS) also noted this bird as "common" at the island on December 5, 1930.

Larus philadelphia (Ord).

When Anthony was at the island on the above mentioned date he found Bonaparte's Gull present in flocks of "thousands." We did not meet with it in the Gulf other than on the Lower California side where it was fairly common.

Larus heermanni Cassin.

During the winter this resident species is much more generally distributed than in the breeding season. On Tiburón, as indeed throughout the Gulf area, we found it to be fairly common. Therefore many of the individuals of this species are probably resident in the vicinity of the breeding grounds and by no means all of them migrate north up the Pacific coast.

Thalasseus maximus maximus (Boddaert).

On the evening of January 1, a good-sized flock of Royal Terns was seen in company with several other species on the beach at Freshwater Bay at the northern end of the island.

Thalasseus elegans (Gambel).

Noted in small numbers at Petrel Bay on December 28 and 29 and more commonly at Freshwater Bay on January 1.

Endomychura craveri (Salvadori).

Craveri's Murrelets were frequently seen in pairs in the channel between Kino Bay and the island on December 28, and again along the west side of the island on January 1.

Zenaidura macroura marginella (Woodhouse).

The Western Mourning Dove is very probably a resident on Tiburón since it was noted by Townsend in April, as well as by ourselves. Several birds were seen daily, but the species could by no means be called abundant.

Melopelia asiatica mearnsi Ridgway.

Several White-winged Doves were noted by us at Petrel Bay on December 28 and 29. Since Townsend also records the species as present in April it is probably resident.

Speotyto cunicularia hypugaea (Bonaparte).

One Burrowing Owl was flushed from a shallow cavity under some lava blocks at the edge of the hills facing Petrel Bay on December 29.

Asio otus wilsonianus (Lesson).

In the mesquite thickets at Petrel Bay a flock of five of these owls was found on the afternoon of December 28 and one of them was collected. On December 29 the four survivors were flushed again from the same thicket and in addition Pemberton saw another small assemblage a mile to the south of the first group.

Asio flammeus flammeus (Pontoppidan).

At Freshwater Bay at the north end of the island a Short-eared Owl was repeatedly started from thick *Salicornia* growth on the low ground just back of the beach. Although it was wary and never allowed me to

approach closer than fifty yards, its identity was established without question.

Calypte costae (Bourcier).

Costa's Hummingbird was apparently the only representative of the family present on the island at the time of our visit. It was very common in the brush at Petrel Bay and decidedly less so in the more open country at the south end. One specimen was collected at Petrel Bay on December 28.

Colaptes chrysoides mearnsi Ridgway.

Although several Gilded Flickers were seen in the giant cactus growth at Petrel Bay, they were so wary that none of our party succeeded in taking a specimen. However, through the courtesy of the American Museum of Natural History I have been able to examine the bird collected by Dr. Townsend's collectors on April 13, 1911, and find it to be of this race. That this species is resident is shown by the old nest holes in the giant cactus.

Centurus uropygialis uropygialis Baird.

This is the only woodpecker on the island which is to be classed as common. We found it in numbers in the mesquites and giant cactus at Petrel Bay where old nest holes abounded and where no difficulty was experienced in collecting five specimens. Townsend records a bird as taken on April 13, 1911, and Bancroft's collector secured two on May 22, 1930.

As I have remarked on a previous occasion (Trans. San Diego Soc. Nat. Hist., 6, no. 19, 1931, 255) the extreme characters of *uropygialis* are manifest in the Colorado River Valley and closely adjacent regions. Tiburón specimens as well as those from the opposite mainland are very similar to the Colorado River birds, in fact are decidedly closer to typical *uropygialis* than are examples from interior northern Sonora.

Dryobates scalaris cactophilus Oberholser.

A pair of Cactus Woodpeckers which were collected at Petrel Bay on December 29 are typical of this race, which is the one occurring on the neighboring mainland south as far as Kino Bay, though doubtfully much further.

Myiarchus cinerascens cinerascens (Lawrence).

The Ash-throated Flycatcher was fairly common at all of the three

points on the island at which we landed, but I suspect that some of the birds present in the winter are only transients. Tiburón breeding birds and those from the Sonora coast from Kino Bay south to Guaymas are, while definitely *cinerascens,* nevertheless individually intermediate toward *Myiarchus cinerascens inquietus* Salvin and Godman of the Alamos District and southward. Some of the seven examples taken on the present trip are of this latter type while some are typical *cinerascens.* This species was first recorded from the island by Townsend on April 11 and 12, 1911, and Bancroft's party took three specimens on May 22, 1930. More detailed discussion on the subject of the intergradation of *cinerascens* and *inquietus* may be found in the Transactions of the San Diego Society of Natural History, vol. 6, 1931, p. 260.

Empidonax traillii brewsteri Oberholser.

Known only from the specimen taken by Bancroft's party on May 22, 1930, at an unknown point on the island. I have examined the specimen whose appearance, as well as the date of capture, suggests that it was a breeding bird.

Empidonax wrightii Baird.

Several small flycatchers were heard calling in the mesquites at Petrel Bay and one of these which was collected on December 28, proved to be of this species. Another was taken at Freshwater Bay on January 1.

Empidonax difficilis difficilis Baird.

One specimen, which doubtless was a migrant, is recorded by Townsend as collected on April 12, 1911.

Progne subis hesperia Brewster.

The circumstances of the taking of the two Western Martins on Tiburón are unknown to me, that is, I do not know whether they were breeding birds or only transients. I have previously reported (Trans. San Diego Soc. Nat. Hist., 6, no. 19, 1931, 269) on these two specimens, which were taken by Bancroft's party on May 22, 1930. They are typical *hesperia* as are known breeding examples from the northern Sonora deserts.

Corvus corax clarionensis Rothschild and Hartert.

Ravens were not uncommon on Tiburón, both inland and along the beaches, but there was no opportunity to collect one.

I use the name *clarionensis* for the insular ravens for the reason that the material from the Gulf area, scanty though it is, leaves no other course possible. The measurements of an adult male from San Estéban Island are in essential particulars as follows: wing, 407 mm.; tail, 223; exposed culmen, 66. Those of an adult female from San Lorenzo Island are: wing, 390 mm.; tail, 208; exposed culmen, 64; while those taken from a dead bird of unknown sex found on Raza Island are: wing, 384 mm.; tail, 213; exposed culmen, 67. Whether the ravens from the Sonora littoral belong to the insular race or to *Corvus corax sinuatus* Wagler, which is the form that occurs in the interior, there is no means of determining at this time.

Auriparus flaviceps fraterculus van Rossem.

This bird was first recorded from Tiburón by Townsend under the name of *Auriparus flaviceps lamprocephalus* Oberholser. Later, when the present writer separated the Sonora verdin from the Cape form, he included the single specimen taken by Bancroft on Tiburón under *fraterculus,* because of its size and type of head coloration, but at the same time commented on the grayish body coloration. In the light of more freshly plumaged material taken on the present trip on both Tiburón and San Estéban Islands I am still of the opinion that this name is the best one to employ. Birds from the two islands are slightly but definitely grayer even than Kino Bay intergrades between *fraterculus* and *Auriparus flaviceps acaciarum* Grinnell, but I believe the differences to be too intangible to recognize by name.

Troglodytes aëdon parkmanii Audubon.

House Wrens were present in small numbers in the scrub at Petrel Bay where a specimen was taken on December 28. Their status is most likely that of winter visitants.

Heleodytes brunneicapillus seri subsp. nov.

Type.—Male in relatively fresh, unabraded, midwinter plumage; no. 50,262, collection of California Institute of Technology; Petrel Bay, just south of Narragansett Point, east side of Tiburón Island, Sonora, Mexico; December 29, 1931; collected by A. J. van Rossem; original no. 13,925.

Subspecific characters.—Similar in size and distribution of ventral spotting to *Heleodytes brunneicapillus brunneicapillus* (Lafresnaye) of southern Sonora, but whole plumage paler and grayer, the flanks only tinged with "light pinkish cinnamon," and the white streaks on the upper surface broader and more continu-

ous. Measurements of the type are: wing, 82.5 mm.; tail, 78.5; exposed culmen, 22.4.

Range.—Tiburón Island, Sonora, Mexico.

Remarks.—Townsend first recorded the Cactus Wren from Tiburón under the name of *brunneicapillus* on the basis of a specimen taken there April 12, 1911. This specimen and another which was taken by Bancroft on May 22, 1930, have been previously reported and their peculiarities commented on (Trans. San Diego Soc. Nat. Hist., 6, no. 19, 1931, 273), but for various reasons I did not at that time feel justified in naming the race. However, the eight examples taken on the present visit show that the characters formerly noted are constant, and there is no reason to delay further the definition of this insular race.

The characters given by Ridgway (Birds No. and Mid. Amer., 3, 1904, 517) for the distinguishing of the northern race *Heleodytes brunneicapillus couesi* (Sharpe) from *brunneicapillus*, namely, "larger and with coloration paler, especially the buff of posterior underparts," are not such as can be relied on with any degree of certainty. In our series of 63 *couesi* and 47 *brunneicapillus* in the collections at the California Institute of Technology, size is so variable that few birds can with certainty be identified by such means; in fact Ridgway's own measurements show only an average of less than 3 mm. difference in the wing and tail in favor of the northern bird. In the coloration of the flanks the two lots appear to be absolutely identical in color and in the area involved. The differences of most importance are the lighter, brighter, and more reddish dorsal coloration, the coalescence of the ventral spotting into a well-defined patch on the throat and upper chest and a slightly but consistently longer culmen in *couesi*, and conversely, a darker, duller, and more brownish dorsal coloration, a diffusion of throat and chest markings, more heavily spotted flanks, and a shorter culmen are characteristic of *brunneicapillus*.

In the absence of color on the underparts *seri* bears some resemblance to *Heleodytes brunneicapillus purus* van Rossem of the San Ignacio District of Lower California, but the upperparts of *seri* are very much grayer and it has the black centered tail of the continental series, not the fully barred one of the Lower California races.

Salpinctes obsoletus obsoletus (Say).

The characteristic notes of the Rock Wren were heard not infrequently on the lava flows on the hills back of Petrel Bay and at least two birds were seen. However, no specimens were taken.

Mimus polyglottos leucopterus (Vigors).

Mockingbirds were noted by Townsend as "fairly common" in April, 1911, but not more than a dozen were seen by ourselves. They were all in the thickets at Petrel Bay.

Toxostoma bendirei (Coues).

Bendire's Thrasher was noted only once when a specimen was taken

in the comparatively open desert at the south end of the island on December 30. This species is presumably resident since it nests coastwise south as far as Guaymas. The bird recorded under this name by Townsend proves on examination to be of the next mentioned species.

Toxostoma curvirostre insularum van Rossem.

Townsend records this thrasher, under the name of *Toxostoma bendirei* (Coues), as taken on Tiburón April 3, 1911, a misprint for April 13, as examination of the bird itself shows. Bancroft took two on May 22, 1930, which were subsequently recorded in the original description of this island race whose range includes San Estéban Island as well as Tiburón. On the present occasion one was taken at Petrel Bay on December 29 and another at the south end on December 31. The characters of *insularum* are, as previously diagnosed, a relatively pale, ashy coloration, but of the size, proportions, and with the pronounced breast spots of *Toxostoma curvirostre maculatum* (Nelson). I can appreciate no differences whatever between the single specimen (the type) from San Estéban and the five Tiburón birds, save that Townsend's bird, which is now in the American Museum of Natural History, has become browner in the twenty-one years which have elapsed since it was collected. It is a well-known fact that most, if not all, of the thrashers of this genus undergo a relatively rapid post-mortem change by which the grays take on a definitely brownish tone with the passage of time.

Polioptila melanura curtata subsp. nov.

Type.—Female in comparatively fresh, unabraded, midwinter plumage; no. 50,209, collection of California Institute of Technology; Petrel Bay, east side of Tiburón Island, Sonora, Mexico; December 28, 1931; collected by A. J. van Rossem; original no. 13,872.

Subspecific characters.—In coloration nearest to *Polioptila melanura lucida* van Rossem of the Colorado Desert District, but flanks, under tail coverts, and back of females and young males slightly browner and more contrasted with the cinereous portions of the body plumage; in size nearest to *Polioptila melanura margaritae* Ridgway of the Cape District of Lower California, but still smaller, in fact the smallest known race of this species. Wing and tail measurements of the type are 42.0 mm. and 44.5 mm. respectively.

Range.—Tiburón Island, Sonora, Mexico.

Remarks.—The eight specimens of this race (three males and five females) which are available for examination at this time average, in comparison with main-

land specimens of *lucida* and *margaritae*, as follows:

	Wing	*Tail*
8 *curtata* from Tiburón Island	41.8	44.0
10 *margaritae* from the Cape District	43.6	45.5
25 *lucida* from the range	45.0	49.5

Thus *curtata* is distinguished from *lucida*, the only race with which it can be confused in color, by a size difference of about 10 per cent and from *margaritae*, the nearest to it in size, by a decided difference in color, *margaritae* being the duller, darker, and more plumbeous of the two.

This species was detected first by Townsend who records, as *Polioptila plumbea*, a specimen taken on Tiburón April 12, 1911, and later by Bancroft who collected a bird on May 22, 1930, and which was later recorded by myself as *lucida*. We found it to be not uncommon in low scrub at all three of the points at which we touched.

Corthylio calendula cineraceus (Grinnell).

Ruby-crowned Kinglets were observed by both Pemberton and myself at Petrel Bay. However, no specimens were collected.

Phainopepla nitens lepida Van Tyne.

At Petrel Bay and at the south end of the island Phainopeplas were rather common in the mesquite thickets and specimens were collected at both places. Whether this bird is a resident or only a winter visitant is not known. The fact that Townsend took the species as late as April 12 would indicate the former.

Lanius ludovicianus sonoriensis Miller.

Townsend, under the name of *Lanius ludovicianus gambeli*, noted the species on Tiburón in April, 1911, but he lists no specimens. The single shrike taken by ourselves, at the south end of the island on December 31, is a typical female *sonoriensis* in color and measurements. Several other shrikes were seen, both at the south end and at Petrel Bay, but whether the dark-colored, migratory *gambeli* was present among them we could not get close enough to determine.

Vireo vicinior Coues.

The Gray Vireo was found to be present in small numbers in the brush at Petrel Bay where three specimens were taken on December 29. This vireo is far from typical of the family in habits for its quick, jerky movements and cocked-up tail led us more than once to mistake it for a wren. The coast of central Sonora is evidently a favored wintering place of the Gray Vireo for, in addition to the Tiburón records, they were

detected as fairly common and specimens were taken at San Carlos Bay, December 24, and at San Estéban Island, January 11.

Vermivora celata lutescens (Ridgway).

A Lutescent Warbler (definitely of this subspecies) was shot in the mesquites at Petrel Bay on December 28, but was so badly mutilated that it was not preserved as a specimen. Pemberton saw several more individuals which may or may not have been of this race.

Icterus parisorum Bonaparte.

Known only from the record by Townsend that the species was seen at Tiburón April 11, 1911.

Richmondena cardinalis townsendi subsp. nov.

Type.—Female adult, no. 50,272, collection of California Institute of Technology; south end of Tiburón Island, Sonora, Mexico; December 31, 1931; collected by A. J. van Rossem; original no. 13,935.

Subspecific characters.—Similar in size and shape of bill to *Richmondena cardinalis affinis* (Nelson) of the Alamos District of southern Sonora, but coloration of males somewhat lighter red, and with dorsal plumage paler and grayer; coloration of females paler, duller, and grayer buff. Similar also to *Richmondena cardinalis ignea* (Baird) of the Cape District of Lower California, but bill smaller and less tumid, and coloration of females grayer, and slightly paler. Measurements of the type are: wing, 95 mm.; tail, 112; culmen from base, 17.5; depth at base, 14.1; tarsus, 25.3; middle toe minus claw, 17.7.

Range.—Tiburón Island, Sonora, Mexico.

Remarks.—In reviewing the characters of the previously described northwestern forms of the cardinal, namely, *Richmondena cardinalis superba* (Ridgway), *ignea,* and *affinis,* I am at a loss to account for some of the comparative color characters which have been published. The females of all of these races undergo radical color changes in the course of the year, for the plumage is extremely susceptible to fade, and color comparisons must be confined to specimens in comparable states of plumages. The entirely adequate series in the California Institute of Technology collections of skins of all three of the above mentioned races show conclusively that *affinis* is the darkest, and most richly colored of the three, exceeding in this respect even *superba,* and why the females of *affinis* should ever have been said to be grayer and duller than those of *ignea* is incomprehensible except as a *lapsus calami.* The males show such a great range individually in the shade and intensity of red that I am unable to detect any color characters of value, unless it be that the interscapular region of *affinis* is slightly darker than in any of the other three races and with less intermixture of gray in fresh plumage.

Based on size and on the coloration of the females the following comparative

characters distinguish the four races involved:

1. Coloration richer and browner, particularly below.
   A. Slightly darker and size decidedly smaller. *affinis*
   B. Slightly lighter and size decidedly larger. *superba*
2. Coloration duller and paler.
   A. More buffy and with decidedly larger bill. *ignea*
   B. More grayish and with decidedly smaller bill. *townsendi*

The specimen recorded by Dr. Townsend as taken on Tiburón Island on April 12, 1911, has been loaned to me through the courtesy of the American Museum of Natural History. Although this bird was referred to *affinis* with some misgiving, I am unable to verify the distinguishing characters, "smaller, with larger feet," which were suggested. However, in consideration of the fact that Dr. Townsend first suggested the possible distinctness of the Tiburón cardinal and also that under his direction the first collection of importance was made, the race properly may be named in recognition of his contributions.

We found cardinals to be rare since only two males were taken at Petrel Bay and two females at the south end of the island. All were in a mesquite association.

Passerina amoena (Say).

The Lazuli Bunting was reported by Townsend as observed on the island on April 13, 1911, but apparently no specimens were taken.

Carpodacus mexicanus frontalis (Say).

House Finches were first reported by Townsend who thought it probable that the birds he observed, but did not collect in April, 1911, belonged to the northern race. Bancroft took six specimens on May 22, 1930, and we secured another at Petrel Bay on December 29, 1931. The seven available skins are all clearly referable to the race *frontalis*.

Oberholseria chlorura (Audubon).

The cat-like notes of this very common winter visitant were the first bird notes we heard on landing at Petrel Bay. During our whole stay we found Green-tailed Towhees to be very much of a nuisance. Not only were they forever being mistaken for other species, but their mewing alarm notes served to keep more desirable birds under cover. Townsend observed the species here in April [12 or 13], 1911, though at this late date probably in lesser numbers than we found in midwinter.

Pipilo fuscus jamesi Townsend.

This interesting race of the brown towhee shares with the endemic race of the Gambel's quail the distinction of being the most sharply dif-

ferentiated of the Tiburón resident birds. It was originally discovered and named by Dr. Townsend on the basis of four specimens taken on the island on April 12 and 13, 1911, probably in the vicinity of Willard's Point. Although this bird was an object of especial search we found it only in the mesquite association at Petrel Bay where on December 28 and 29 a total of seven specimens was taken and possibly an equal number was seen or heard.

The relationships of *jamesi* are obviously with *Pipilo fuscus intermedius* Nelson of the Alamos District and not with *Pipilo fuscus mesoleucus* Baird of the Eastern Plains District of the northeastern and north-central part of the state. No brown towhees are known today from anywhere on the coast north of Guaymas nor from any inland point closer than Pesqueira, distant one hundred miles and seventy miles respectively, at both of which places *intermedius* is the race present. The race *jamesi* resembles *intermedius* in the duller and less contrasted crown patch, and in the gray plumage tones. However, the extreme pallor and ashiness of the entire plumage is not even approached in any other race of this species. The bill is the length of that of *intermedius,* but is notably "stubbier," and the wing and tail are shorter even than those of *Pipilo fuscus albigula* Baird of the Cape District. It may be mentioned here that the colored plate which accompanies the original description of *jamesi* is very much too red and with the exception of the tail is too dark, and with the crown cap showing too much contrast. In all seven of our specimens the dorsal plumage, and sides of breast and flanks are just about intermediate between the upperparts and the breast as pictured, and the crown is but slightly redder and but little darker than the back of the bird illustrated. Comparative measurements of the males of *mesoleucus, intermedius,* and *jamesi* are as follows:

	Wing	*Tail*	*Exp. Cul.*	*Depth*	*Tarsus*	*Mid. Toe minus Claw*
10 *mesoleucus* from Arizona.	94.0	102.5	15.3	10.2	26.2	18.4
7 *intermedius* from Sonora.	90.1	100.1	14.9	9.9	25.0	18.1
6 *jamesi* from Tiburón Island.	84.1	96.8	14.8	10.3	24.7	18.4

Calamospiza melanocorys Stejneger.

Large flocks of Lark Buntings were noted daily and were found at all three points visited. They were particularly numerous in the more open ground at the south end of the island. No specimens were collected. This bird was noted on Tiburón by Townsend as late as April [12 or 13], 1911.

Passerculus sandwichensis rostratus (Cassin).

At many points along the beaches and on low ground immediately back of them was a dense growth of *Salicornia,* in and about which Large-billed Sparrows were fairly common. Whether this species breeds on Tiburón or whether the birds observed were only winter visitants must be determined at some future date. Townsend, in 1911, found them present as late as April 11 or 12, and I rather suspect that some at least remain to breed. Two specimens were collected on December 29 and 30 respectively.

Amphispiza bilineata pacifica Nelson.

While the single specimen which was taken at Petrel Bay on December 28 is unquestionably *pacifica,* I very much doubt if it represents the breeding race. It is, of course, entirely possible that the relatively pale, ashy *Amphispiza bilineata cana* van Rossem is confined to San Estéban Island, but in at least one other instance (*Toxostoma*) the range of a Tiburón race includes San Estéban and I suspect that the same will prove to be the case with the present species.

Spizella breweri breweri Cassin.

An abundant winter visitant which was found everywhere on the island. A specimen was taken at Petrel Bay on December 28.

Zonotrichia gambelii gambelii (Nuttall).

Gambel's Sparrows were very common in all types of brushy cover and because of the flurry they made whenever a flock was flushed they handicapped us not a little. Several were shot by accident or by mistake and all of these were *gambelii.* One specimen, taken at the south end of the island on December 31, was prepared.

Melospiza lincolnii lincolnii (Audubon).

On the afternoon of December 29 I shot a Lincoln's Sparrow in the *Salicornia* growth on the beach at Petrel Bay. The bird was hopelessly mutilated and was not prepared, but as nearly as could be determined in the field was of the typical subspecies. Townsend records a specimen as taken at Tiburón on April 12, 1911.

PLATE 8

Fig. 1. South-eastern side of Tiburón Island looking north-west toward the central mountains. The barren character of the island is nowhere better illustrated than here at Petrel Bay where most of the specimens were collected.

Fig. 2. The extreme south end of Tiburón Island, illustrating the Lower Sonoran vegetation and general aspect of the island. The only Arid Tropical plants evident in the picture are *Jaquinia pungens*, the dark, shrub-like trees in the middle distance.

Fig. 1

Fig. 2

PLATE 9

Figs. 1, 2. Typical Arid Tropical Zone vegetation at Kino Bay on the Sonora mainland opposite the south end of Tiburón Island. These views are presented as contrasts to the Lower Sonoran Zone vegetation which is predominant on the island.

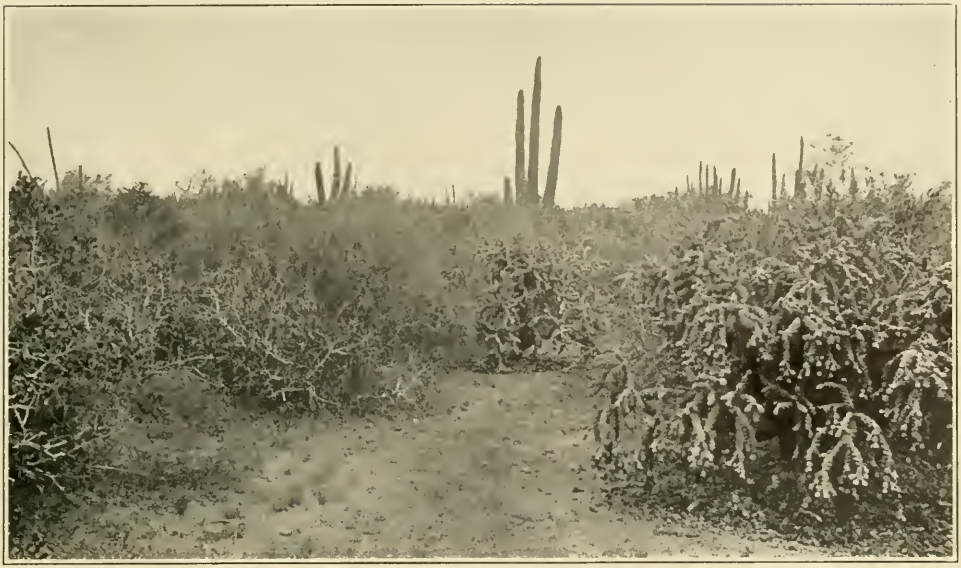

Fig. 1

Fig. 2

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VOL. VII, NO. 13, pp. 151-152 JULY 28, 1932

EL SALVADOR RACES OF DACTYLORTYX THORACICUS

BY

A. J. VAN ROSSEM

California Institute of Technology

Four years ago the late Donald R. Dickey and the writer named a race of *Dactylortyx thoracicus* from El Salvador,[1] basing the characters on a composite series of three specimens from Volcan de San Miguel and six from Mt. Cacaguatique. I recently had occasion to go over again the series upon which the new race was based and at once realized that we had included in the description two perfectly distinct forms. Since the type of *Dactylortyx thoracicus salvadoranus* is from Volcan de San Miguel, it is the interior, cordilleran race which requires to be named.

Dactylortyx thoracicus taylori subsp. nov.

INTERIOR LONG-TOED QUAIL

Type.—Fully adult male in the brown-throated phase of plumage; no 16,650, collection of Donald R. Dickey; Mt. Cacaguatique, Dept. San Miguel, El Salvador, altitude 3500 feet; December 17, 1925; collected by A. J. van Rossem; original no. 9724.

Subspecific characters.—Ventral coloration grayer than that of *Dactylortyx thoracicus chiapensis* Nelson and browner than that of *Dactylortyx thoracicus salvadoranus* Dickey and van Rossem, though in this respect closer to the latter; tarsus shorter than that of either *chiapensis* or *salvadoranus;* toes shorter than in *chiapensis* and about equal to *salvadoranus.* More briefly, *taylori* is intermediate

[1] Proc. Biol. Soc. Wash., Vol. 41, pp. 129-130, June 29, 1928.

in coloration between *chiapensis* and *salvadoranus*, but has a tarsus shorter than either.

Range.—Known only from the oak association of the Arid Upper Tropical Zone on Mt. Cacaguatique, but probably more or less widely distributed over similar areas in southern Honduras.

Remarks.—The Volcan de San Miguel Quail, *salvadoranus*, is, of course, confined to that mountain and because of complete isolation cannot intergrade with *taylori*, or for that matter any other race.

Mr. Frederic W. Taylor, for whom the interior race is named, was Director General of Agriculture for El Salvador during most of the time of my field work in that country and due to his interest and cooperation I was able to reach many relatively inaccessible localities with a minimum expenditure of time and effort.

Measurements.—

	Tarsus	*Middle toe minus claw*
5 ♂ *chiapensis*	35.7-37.8	30.0-33.0
2 ♂ *salvadoranus*	32.8-34.0	27.0-28.5
3 ♂ *taylori*	31.0-32.0	27.0-29.7

Females parallel males in comparative measurements.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VII, No. 14, pp. 153-156 July 28, 1932

AN UNDESCRIBED GOPHER, GENUS THOMOMYS, FROM SOUTHEASTERN CALIFORNIA

BY

William Henry Burt

California Institute of Technology

Our knowledge of the geographic distribution of the pocket gophers in southeastern California is as yet far from complete, chiefly because there are vast areas from which no pocket gophers are represented in collections. However, it is only reasonable to suspect that pocket gophers do occur, more or less locally perhaps, throughout these areas. Grinnell (Univ. Calif. Publ. Zool., 38, 1-10, pls. 1 and 2, October 17, 1931) has recently described a gopher (*Thomomys providentialis*) from the Providence Mountains, California, which is apparently more closely related to *Thomomys scapterus* Elliot from the Panamint Mountains than to the neighboring desert-valley forms of the species *bottae* (for the use of the name *bottae* instead of *perpallidus* see Hall, Univ. Calif. Publ. Zool., 38, 325-333, February 27, 1932). Both *providentialis* and *scapterus* are set off rather sharply by cranial characters from each of the neighboring desert-valley races, *Thomomys bottae amargosae* Grinnell, *Thomomys bottae perpes* Merriam, and *Thomomys bottae mohavensis* Grinnell. In this same connection it is significant to note that gophers from Greenwater, in the Black Mountains to the east of Death Valley, also fall, both in skin and skull characters, with *providentialis* and *scapterus* rather than with the desert-valley forms. However, the Greenwater gopher differs, as indicated below, in certain pertinent details from either *providentialis* or *scapterus*.

From his studies Grinnell (*loc. cit.*) has concluded, quite rightly it seems, "that in *Thomomys* the female is the sex that in cranial features shows specific and subspecific characters with most conservatism." In accord with this viewpoint a female has been selected as type of the species named and described below, and in the comparisons females have been used exclusively. Topotypical series of *providentialis* and *scapterus* have been available for comparative purposes through the courtesy of the staff of the Museum of Vertebrate Zoology, University of California at Berkeley.

Thomomys oreoecus[1] sp. nov.

Greenwater Pocket Gopher

Type.—Breeding female, skull and skin; no. K 364, collection of Donald R. Dickey, Greenwater [Black Mountains, eight miles southwest of Ryan], Inyo County, California; altitude 4300 feet; May 21, 1922; collected by Laurence M. Huey.

Measurements of type.—Total length, 200 mm.; tail vertebrae, 68; hind foot, 27. Skull: basilar length of Hensel, 29.1; length of nasals, 11.5; zygomatic breadth, 20.8; mastoid breadth, 18.5; interorbital constriction, 6.2; alveolar length of upper molar series, 7.5; width of rostrum, 7.5; extension of premaxillae posterior to nasals, 1.6.

Distribution.—Known only from the type locality, but probably extends southward along the mountain ranges of eastern California.

Characters.—A small, pallid *Thomomys,* the sexes of which are nearly the same in size; apparently most closely related to *Thomomys providentialis* Grinnell from the Providence Mountains, but somewhat paler and differing in other respects as described below. Color of type: new pelage on anterior half of upperparts dusky "cinnamon-buff" (colors in quotation marks from Ridgway, Color Standards and Color Nomenclature, 1912); underparts similar to upperparts, but slightly paler; tail and feet whitish; black post-auricular patches distinct; cheek border of mouth "fuscous." Worn pelage on posterior half of upperparts and sides somewhat paler and duller than the fresh pelage. Skull small with rounded, anteriorly tapering zygomatic arches; mastoid breadth relatively great as compared with closely related forms; interparietal small; nasals short; bullae globular; dentition light.

Comparisons.—As compared with a series of *Thomomys scapterus* Elliot, taken at the same season of the year, the Greenwater specimens differ in the following respects: size smaller, the average body length of five adult females of *oreoecus* being 132 mm. whereas that of three adult females of *scapterus* is 149; foot smaller; ear smaller; coloration distinctly paler; black post-auricular patch more distinct; underparts washed with yellowish instead of whitish, being

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1 ὄρος=mountain; οἶκος=nest or burrow.

more nearly the same color as the upperparts whereas in *scapterus* there is a marked contrast between the color of the upperparts and that of the underparts. Skull shorter and relatively wider, the average mastoid breadth being 63.3 per cent of the average basilar length of Hensel in *oreoecus* as compared with 58.9 per cent in *scapterus;* nasals longer; dentition weaker; premaxillae do not extend as far beyond posterior termination of nasals; zygomatic arches more nearly straight sided, less roundly spreading; no indication of an interparietal fontanel; interparietal smaller, more rounded; bullae more inflated and globular; pterygoid wings in lateral aspect more sharply curved with a heavier hamular process.

Differences between *oreoecus* and *providentialis* are less evident than those between *oreoecus* and *scapterus*. Externally *oreoecus* and *providentialis* are similar, but in the series at hand the specimens of *oreoecus* have larger ears and are slightly paler than specimens of *providentialis*. In the skulls the differences are more pronounced, but here as in the skins the close relationship of the two forms is apparent. The skulls of *oreoecus* differ from those of *providentialis* in being actually and relatively shorter and wider, the average mastoid breadth being 63.3 per cent of the average basilar length of Hensel in *oreoecus* as compared with 61.4 per cent in *providentialis*. In addition the interparietals are narrower and the nasals shorter and more deeply notched posteriorly.

By the small size and rounded, anteriorly tapering zygomatic arches *oreoecus* may be distinguished from any of the neighboring races of *Thomomys bottae,* all of which are larger with more squarely built skulls.

Remarks.—Although separated from *providentialis* by some 120 miles of mountains and desert valleys and from *scapterus* only by Death Valley, the affinities of *oreoecus* are apparently closer to *providentialis* than to *scapterus*. It may be that further collecting in the intervening mountain ranges between Greenwater and the Providence Mountains, if pocket gophers are to be found there, will show that *providentialis* and *oreoecus* are no more than subspecifically distinct. Death Valley has apparently been an effective barrier separating *oreoecus* and *scapterus*. It seems best to give full specific rank to *oreoecus* until the true relationships of the gophers of this region are better known.

Specimens examined.[2]—*Thomomys oreoecus,* 11, all from the type locality (Dickey collection); *Thomomys providentialis,* 5, 3 from Purdy and 2 from Leastalk (Museum of Vertebrate Zoology collection); *Thomomys scapterus,* 5, Hanaupah Cañon, Panamint Mountains (Museum of Vertebrate Zoology collection).

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[2] Since the above description was written, Huey (Trans. San Diego Soc. Nat. Hist., v. 7, pp. 43-44, December 19, 1931) described a pocket gopher (*Thomomys argusensis*) from the Argus Mountains, California, which apparently belongs to this group of mountain gophers. I have seen the specimens of *argusensis* used in the description and they differ appreciably from *oreoecus,* especially in larger size, darker coloration, and smaller auditory bullae.

TRANSACTIONS

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A NEW SPECIES OF POCKET GOPHER FROM SOUTHERN ARIZONA

BY

Laurence M. Huey

Curator of Birds and Mammals, San Diego Society of Natural History

The present writer has been interested in the gophers of the higher mountains of southern Arizona for the past four years. His attention was first attracted by the difference from neighboring lowland forms shown in a series of gophers taken at Rustler Park, Chiricahua Mountains, Arizona, in 1928. In order to understand more clearly the relationship of the Rustler Park specimens, such material as was available from surrounding territory was borrowed from the collections of the California Academy of Sciences[1] and the United States Biological Survey.[1] Study of this accumulated collection revealed further problems to be solved, and it was thought best to await the accession of collections from other important localities that were not represented.

In the summer of 1930, S. G. Harter of the San Diego Natural History Museum staff was detailed to collect a series of *Thomomys* from the higher parts of the Huachuca Mountains, Arizona. Meanwhile, Dr. W. H. Burt of the California Institute of Technology had spent several weeks in the Santa Rita Mountains, Arizona, and secured an excellent series of gophers. This locality, also, was one of especial interest, from which specimens were needed. Dr. Burt, hearing of the writer's interest in the *Thomomys* of southern Arizona, most generously placed his specimens at the writer's command.[1]

[1] The writer herewith acknowledges with thanks loans from the following institutions, through the courtesy of their representatives: the California Academy of Sciences, through Mr. Harry S. Swarth; the California Institute of Technology (collections of Donald R. Dickey), through Dr. W. H. Burt; the United States Biological Survey, through Mr. E. A. Goldman.

Recently Goldman[2] published the descriptions of a number of forms of *Thomomys* from several different higher ranges of southern Arizona, including the Chiricahua Mountains. However, there was no mention made of *Thomomys* from the Santa Rita Range and as Burt's series from the higher reaches of these mountains shows divergent characters of extreme interest, it seems advisable to name a new species of gopher from this locality.

Thomomys burti[3] sp. nov.

Santa Rita Mountains Pocket Gopher

Type.—From Madera Canyon, Santa Rita Mountains, Santa Cruz County, Arizona; altitude 6000 feet; no. 18899, collection of Donald R. Dickey; adult female; collected by W. H. Burt, May 29, 1931; original no. 2830.

Characters.—A small eared, richly colored, dark, small gopher of the *fulvus* type, having a very broad dark dorsal stripe over its entire body length. The feet are relatively small and light boned. Cranially, this species has very small, flattened and deflated bullae. The rostrum is heavy, while the profile of the skull tends to the circular, with the greatest arc of curvature over the nasal portions. Posteriorly, the brain case has a very flattened appearance, due to the small size of the bullae. In general the skull of *burti* is light boned and not angular. The mammae are in 3 pairs, inguinal 2-2, pectoral 1-1.

Measurements.—See table, page 160.

Range.—Known only from the higher parts of the Santa Rita Mountains, Arizona.

Comparisons.—The color of *burti* is unlike that of *Thomomys fulvus intermedius* from the Huachuca Mountains to the eastward, or *Thomomys fulvus modicus* from different localities about the base of the Santa Rita range. When assembled in series there is a decided purplish cast, unlike that of any Arizona *Thomomys* known to the writer. The skull characters also contrast with those of the two above mentioned forms. The outstanding character is that of profile curvature, which is decidedly rounded, as before mentioned. This is much in evidence when compared with the skulls of either *intermedius* or *modicus*, which have a flattened or depressed outline in the orbital regions. The mammae of *burti* are limited to three pairs, while those of *intermedius* and *modicus* are four.

The three characters found only in *burti*—color, skull curvature, and mammae—which have no tendency toward intergradation with the surrounding forms, warrant the designation of this gopher as a full species.

Taxonomic Discussion.—The status of the western gophers is yet far from clear. In his recent paper,[2] Goldman restricts the group *fulvus* to the eastern and southern side of the Colorado River, which he considers a barrier. This barrier,

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[2] Journ. Washington Acad. of Sci., Vol. 21, No. 17, pp. 416-426, Oct. 19, 1931.

[3] Named in honor of Dr. W. H. Burt of the California Institute of Technology.

in the present writer's mind, is far from stable. It is his opinion that the capricious meandering of this river over its delta offers no barrier to *Thomomys*, as large areas of land are shifted without inundation from one side to the other by the ever changing channels.

Goldman's suggestion that the early specific name *bottae* replace *perpallidus* has been met with approval by Hall.[4, 5] There seems ample proof to justify this move. The gopher relationships found by Grinnell over Walker Pass, Kern County, California, and reported in Hall's paper,[4] have their counterpart in a similar situation in San Diego County, namely the San Felipe-Yaqui Wells outlet towards the Colorado Desert. Specimens in the collection of the San Diego Society of Natural History of *Thomomys bottae nigrescens* and *Thomomys perpallidus* show definite linkage. There are several such coast-to-desert passes where no geological barriers exist, in the form of huge rocky dikes or rocky canyons uninhabitable to gophers, where, with careful collecting, these results could probably be duplicated.

With such examples of *bottae* intergradation already proven, the whole southwestern gopher population might be involved and a great many species be found related. If so, the present nomenclature of *Thomomys* would be thrown into a chaotic condition, and in need of a modern revision. This, however, would not seem advisable until a thorough investigation of gophers has been made, similar to Howell's[6] "Individual and Age Variation in *Microtus montanus yosemite*." There would then be a better understanding of each form, and a measure by which slight variations could be interpreted.

Specimens examined.—Thomomys fulvus toltecus: Chihuahua, Mexico, 3 (from Colonia Diaz). *Thomomys fulvus modicus*: Arizona, 6 (2 from Tucson, Pima County; 4 from Tubac, Santa Cruz County). *Thomomys fulvus intermedius*: Huachuca Mountains, Cochise County, Arizona, 15 (4 from Ft. Huachuca [type locality]; 3 from Ramsey Canyon; 5 from head of Ramsey Canyon; 3 from Miller Canyon). *Thomomys burti*: Madera Canyon, Santa Rita Mountains, Arizona, 16 (2 from altitude 4800 ft.; 2 from 5000 ft.; 1 from 5200 ft.; 11 from 6000 ft.)

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[4] Univ. Calif. Publ. Zool., Vol. 38, No. 4, pp. 325-333, Feb. 27, 1932.

[5] Proc. Biol. Soc. of Wash., Vol. 45, pp. 67-70, April 2, 1932.

[6] Journ. Agric. Research, Vol. XXVIII, No. 10, pp. 977-1016, June 7, 1924.

Measurements of *Thomomys burti*
from Madera Canyon, Santa Rita Mountains, Santa Cruz County, Arizona. Altitude 6000 feet.

Collection of Donald R. Dickey	Sex	Date 1931	Total Length	Tail	Hind Foot	Ear	Basilar length of Hensel	Nasals	Zygomatic Breadth	Width of rostrum at middle	Interorbital constriction	Alveolar length of upper molar series
18905	♂	May 30	190	56	28	4	31.3	12.5	21.8	7.7	6.9	7.3
18906	♂	May 30	187	56	27	3	30.2	12.4	21.6	7.7	6.9	8.0
18924	♂	June 1	188	58	26	4	30.4	12.2	20.3	7.2	6.5	7.2
18899*	♀	May 29	177	55	25	3	28.2	10.7	20.0	7.1	6.5	7.5
18914	♀	May 31	183	54	25	4	28.7	11.1	20.4	7.4	6.9	7.7
18922	♀	June 1	178	58	25	3	28.8	11.1	20.3	7.0	6.8	7.7
18930	♀	June 5	180	57	25	4	29.4	10.8	19.5	7.2	6.1	8.0

* Type

28,898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

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DESCRIPTIONS OF HERETOFORE UNKNOWN MAMMALS FROM ISLANDS IN THE GULF OF CALIFORNIA, MEXICO

BY

WILLIAM HENRY BURT

California Institute of Technology

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

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DESCRIPTIONS OF HERETOFORE UNKNOWN MAMMALS FROM ISLANDS IN THE GULF OF CALIFORNIA, MEXICO

BY

WILLIAM HENRY BURT

California Institute of Technology

In 1928 the late Donald R. Dickey visited the Gulf of California and, although his was primarily a fishing and pleasure trip, he succeeded in bringing back a number of mammals from islands on which he had opportunity to trap. He obtained an especially good series of *Peromyscus* from Tortuga Island which proved to be of an undescribed species. He realized from his hasty visit to the more prominent islands that there was yet much to be learned concerning the mammal life of the islands in the gulf, particularly the smaller ones. Arrangements were therefore made in 1930 for Mr. Harry H. Sheldon to accompany, as mammal collector, Mr. Griffing Bancroft and party on a trip to the gulf in order to continue the work. In spite of adverse conditions Mr. Sheldon brought back a very respectable collection of mammals, but was unable to visit a number of the smaller islands on which small rodents were still to be found.

In the winter of 1931-1932 the writer had the privilege, as a representative from the California Institute of Technology, of accompanying Mr. J. R. Pemberton and a party on a cruise into gulf waters, the object being to bring the work that Mr. Dickey had started more nearly to completion. Because of Mr. Pemberton's keen interest in and kind consideration of our work we were able to visit all of the islands of any importance as far north as Mejía Island in the Gulf of California. As a result of the three trips into the gulf, mammals were collected on many islands that had not been visited previously by mammalogists. The present paper contains descriptions of twenty species and subspecies of the three genera, *Perognathus, Peromyscus,* and *Neotoma,* adding ten islands to the list already known to be inhabited by land mammals.

It is the intention of the writer to publish, in the near future, a general report on the mammals of the islands of the Gulf of California. However, it is thought advisable to describe in the meantime such forms as prove to be new to science, so that the records may be available to other workers in the field.

Genus **PEROGNATHUS.** POCKET MICE

Perognathus baileyi fornicatus subsp. nov.

MONSERRATE ISLAND POCKET MOUSE

Type.—Male adult, skull and skin; no. 50,289, collection of California Institute of Technology; Monserrate Island (latitude 25° 38′ N., longitude 111° 02′ W.), Gulf of California, Lower California, Mexico; December 16, 1931; collected by W. H. Burt; original no. 3187.

Measurements.—Type: Total length, 202 mm.; tail vertebrae, 108; hind foot, 26; ear from crown, 7 (from notch, dry skin, 8.9). Skull: greatest length, 29.1; basal length (groove on incisor to condyle), 24.6; greatest mastoid breadth, 14.3; length of mastoids, 8.8; interorbital constriction, 6.9; length of nasals, 11.1; interparietal, 3.8 x 6.6; alveolar length of maxillary tooth row, 4.2.

Distribution.—Known only from Monserrate Island, Gulf of California, Mexico.

Characters.—A dark-colored insular race of the *Perognathus baileyi* group of pocket mice. Differs from the mainland race *Perognathus baileyi extimus* Nelson and Goldman in distinctly darker coloration with less of the cinnamon overwash, in having a more highly arched skull (antero-posteriorly), smaller, less inflated mastoids, smaller audital bullae, and broader, heavier jugals. The interparietal is also longer and narrower without a distinct fifth anterior angle.

Remarks.—This insular race with its dark coloration and small mastoids is set off sharply from all other races of *Perognathus baileyi.*

Specimens Examined.—Twelve, all from Monserrate Island.

Perognathus penicillatus minimus subsp. nov.

TURNER'S ISLAND POCKET MOUSE

Type.—Male adult, skull and skin; no. 50,424, collection of California Institute of Technology; Turner's Island (latitude 28° 43′ N., longitude 112° 19′ W.), Gulf of California, Sonora, Mexico; December 31, 1931; collected by W. H. Burt; original no. 3322.

Measurements.—Type: Total length, 162 mm., tail vertebrae, 97; hind foot, 20; ear from crown, 5 (from notch, dry skin, 6.2). Skull: greatest length, 23.9; basal length (groove on incisor to condyle), 19.5; greatest mastoid breadth, 12.5; length of mastoids, 7.1; interorbital constriction, 6.2; length of nasals, 9.2; interparietal, 3.6 x 7.1; alveolar length of maxillary tooth row, 3.5.

Distribution.—Confined, as far as known, to Turner's Island, Gulf of California, Mexico.

Characters.—A small, dark-colored race of the *Perognathus penicillatus* group. Coloration of upperparts "blackish brown (1)" (Colors in quotations from Ridgway, Color Standards and Color Nomenclature, 1912) interspersed with "light pinkish cinnamon;" bases of hairs "plumbeous;" dorsal surface of

tail pale "bister;" ventral surface soiled yellowish white; lateral line present, but indistinct. Skull small with small mastoids and audital bullae. Differs from *Perognathus penicillatus seri* Nelson from Tiburón Island in smaller size, darker coloration of upperparts (general tone olivaceous), paler dorsal surface of tail, and smaller skull with smaller, more rounded mastoids. Differs from *Perognathus penicillatus pricei* Allen chiefly in smaller size and more olivaceous, less reddish, coloration and more rounded skull.

Remarks.—Turner's Island lies one and one-fourth miles south of Tiburón, is rather rough, but accessible from the east side. The one specimen of *minimus* was taken in the bottom of a small wash where the soil was slightly sandy. I do not necessarily approve of naming a race on one specimen, but this one is so distinct both in skin and skull characters from any one of a large series of *seri* from Tiburón Island that I do not hesitate to separate it from that race by name.

Specimen examined.—One, the type.

Perognathus spinatus guardiae subsp. nov.

ANGEL DE LA GUARDIA POCKET MOUSE

Type.—Male adult, skull and skin; no. 50,495, collection of California Institute of Technology; Puerto Refugio, north end of Angel de la Guardia Island (altitude 30 feet), Gulf of California, Lower California, Mexico; January 7, 1932; collected by W. H. Burt; original no. 3393.

Measurements.—*Type*: Total length, 164 mm.; tail vertebrae, 89; hind foot, 22; ear from crown, 5 (from notch, dry skin, 6.7). Skull: greatest length, 24.1; basal length (groove on incisor to condyle), 19.6; greatest mastoid breadth, 12.1; length of mastoids, 6.9; interorbital constriction, 6.1; length of nasals, 9.7; interparietal, 3.0 x 7.0; alveolar length of maxillary tooth row, 4.0.

Distribution.—Known only from Angel de la Guardia Island, Gulf of California, Mexico, where specimens were taken in bottoms of washes and on low flat areas.

Characters.—A small-sized, light-colored race of the *Perognathus spinatus* group, resembling *Perognathus spinatus evermanni* Nelson and Goldman from Mejía Island to the north, but somewhat larger and more pallid in coloration. It is in fact the palest member of the *spinatus* group known from the islands of the gulf. Lateral line less distinct than in *evermanni*, rump spines present, but not conspicuous; tail tuft less prominent than in most races of *spinatus*. Skull similar to that of *evermanni*, but interpterygoid space wider and pterygoids less flattened when viewed from ventral surface; interparietal averages smaller. Differs from specimens taken at Concepción Bay on the mainland of Lower California chiefly in smaller size and paler coloration.

Remarks.—Although the channel separating Angel de la Guardia Island from Mejía Island is but 150 yards across, nevertheless it has been an effective barrier in isolating the two populations of pocket mice which have developed along slightly different lines since the time of isolation.

Specimens examined.—Forty-one, all from Angel de la Guardia Island.

Perognathus spinatus marcosensis subsp. nov.

San Marcos Island Pocket Mouse

Type.—Male adult, skull and skin; no. 50,604, collection of California Institute of Technology; San Marcos Island (latitude 27° 13′ N., longitude 112° 05′ W.), Gulf of California, Lower California, Mexico; January 18, 1932; collected by W. H. Burt; original no. 3502.

Measurements.—Type: Total length, 174 mm.; tail vertebrae, 102; hind foot, 22; ear from crown, 5 (from notch, dry skin, 7.8). Skull: greatest length, 25.4; basal length (groove on incisor to condyle), 20.9; greatest mastoid breadth, 12.5; length of mastoids, 7.5; interorbital constriction, 6.2; length of nasals, 9.8; interparietal, 3.6 x 7.1; alveolar length of maxillary tooth row, 3.6.

Distribution.—Known only from San Marcos Island, Gulf of California, Mexico.

Characters.—A small, dark-colored race of *Perognathus,* approaching in external characters specimens from Concepción Bay, Lower California, but differing from them in smaller size, relatively longer tail, relatively longer nasals, smaller interparietal, and paler coloration. Lateral line present but indistinct; median rump spines black-tipped, lateral ones white. Skull small; nasals relatively long, straight sided for posterior one-half; mastoids and audital bullae small. Differs from *guardiae* chiefly in darker coloration and relatively longer tail.

Specimens examined.—Fourteen skins and eighteen skulls, all from San Marcos Island.

Perognathus spinatus pullus subsp. nov.

Coronados Island Pocket Mouse

Type.—Male adult, skull and skin; no. 50,324, collection of California Institute of Technology; Coronados Island (latitude 26° 06′ N., longitude 111° 18′ W.), Gulf of California, Lower California, Mexico; December 20, 1931; collected by W. H. Burt; original no. 3222.

Measurements.—Type: Total length, 192 mm.; tail vertebrae, 111; hind foot, 23; ear from crown, 6 (from notch, dry skin, 8 2). Skull: greatest length, 25.8; basal length (groove on incisor to condyle), 21.3; greatest mastoid breadth, 12.6; length of mastoids, 7.3; interorbital constriction, 6.4; length of nasals, 10.0; interparietal, 4.1 x 7.8; alveolar length of maxillary tooth row, 3.6.

Distribution.—Confined, as far as known, to Coronados Island, Gulf of California, Mexico.

Characters.—A medium-sized, dark-colored race of the *Perognathus spinatus* group; set off sharply from *Perognathus spinatus occultus* Nelson from Carmen Island, its nearest island neighbor, by distinctly darker coloration of upperparts (less yellowish), slightly larger size, longer tail, lighter dentition, longer nasals, and more inflated audital bullae. Differs from specimens taken on the peninsula at Concepción Bay in larger size, slightly paler coloration without the yellowish

lateral line (white of underparts meets the dark upperparts abruptly), and more prominent tuft on end of tail.

Remarks.—Coronados Island is a small volcanic island about one and three-fourths miles long, north and south, and one and one-half miles wide. It is one and one-half miles from the mainland at the nearest point. There is a low sand spit on the southwest side of the island, otherwise it is rough and covered with dark brown (nearly black in some places) lava. The dark color of the pocket mice harmonizes with the dark background of the island.

While specimens from Coronados Island are nearest in color to those from Concepción Bay on the mainland, they are closer to *occultus* from nearby Carmen Island in skull characters and in having the pronounced tuft on the terminal portion of the tail.

Specimens examined.—Eight, all from Coronados Island.

Perognathus spinatus seorsus subsp. nov.

DANZANTE ISLAND POCKET MOUSE

Type.—Female adult, skull and skin; no. 50,307, collection of California Institute of Technology; Danzante Island (latitude 25° 47′ N., longitude 111° 11′ W.), Gulf of California, Lower California, Mexico; December 17, 1931; collected by W. H. Burt; original no. 3205.

Measurements.—Type: Total length, 187 mm.; tail vertebrae, 104; hind foot, 22; ear from crown, 5 (from notch, dry skin, 7). Skull: greatest length, 25.7; basal length (groove on incisor to condyle), 21.4; greatest mastoid breadth, 12.3; length of mastoids, 7.2; interorbital constriction, 6.7; length of nasals, 10.1; interparietal, 3.6 x 7.6; alveolar length of maxillary tooth row, 3.6.

Distribution.—Known only from Danzante Island, Gulf of California, Mexico.

Characters.—A medium-sized, dark-colored *Perognathus*, intermediate in color between *occultus* from Carmen Island and *pullus* from Coronados Island. Differs from *occultus* chiefly in darker coloration and in having more rounded audital bullae and smaller mastoids. Differs from *pullus* in somewhat paler coloration with more of the yellowish admixture of upperparts, and in shorter nasals and smaller interparietal. Differs from *Perognathus spinatus bryanti* Merriam from San José Island in smaller size, relatively shorter tail, and darker coloration. Differs from *Perognathus spinatus peninsulae* Merriam in darker coloration, more rounded and more highly arched skull with nasals more deeply emarginate at posterior termination, and in smaller mastoids.

Remarks.—Danzante is another small island only one and one-half miles from the mainland and about the same distance from Carmen Island. It is one and one-half miles in length by nearly a mile in width and is quite rough. The specimens on which the above description is based were taken along a small beach on the southwest side of the island.

Specimens examined.—Seven, all from Danzante Island.

Perognathus spinatus latijugularis subsp. nov.

SAN FRANCISCO ISLAND POCKET MOUSE

Type.—Male adult, skull and skin; no. 18,020, collection of Donald R. Dickey; San Francisco Island (latitude 24° 50′ N., longitude 110° 34′ W.), Gulf of California, Lower California, Mexico; March 19, 1930; collected by H. H. Sheldon; original no. 6298.

Measurements.—Type: Total length, 188 mm.; tail vertebrae, 110; hind foot, 22; ear from notch, 9 (dry skin, 7.1). Skull: greatest length, 25.7; basal length (groove on incisor to condyle), 21.2; greatest mastoid breadth, 12.7; length of mastoids, 7.8; interorbital constriction, 6.7; length of nasals, 9.3; interparietal, 3.7 x 7.5; maxillary tooth row, 4.0.

Distribution.—Known only from San Francisco Island, Gulf of California, Mexico.

Characters.—A medium-sized, dark-colored *Perognathus* with wide, flat jugals. The lateral line is indistinct. Skull medium-sized (see measurements); nasals usually tapering toward posterior termination which is rarely emarginate; interparietal convex on anterior border, but without a distinct fifth angle; supraorbital ridges trenchant; jugals broad, short, and flattened dorso-ventrally; zygomatic processes of maxillary and squamosal heavy and approaching one another in center of arch; mastoids and audital bullae medium, relatively about as in *Perognathus spinatus bryanti* Merriam.

Differs from *bryanti* from San José Island in smaller size, distinctly darker coloration without the yellowish admixture on upperparts, non-emarginate nasals at posterior termination, heavier jugals, and interparietal without fifth anterior angle. Differs from *Perognathus spinatus lambi* Benson from Espíritu Santo Island in darker, less tawny coloration, darker colored ears, greater antero-posterior length of interparietal, and posteriorly tapering nasals. Differs from *peninsulae* in darker coloration and heavier jugals.

Remarks.—The San Francisco Island Pocket Mouse is set off sharply from *bryanti* to the north, *lambi* to the south, and *peninsulae* from the peninsula to the west, by its darker coloration and broad flattened jugals. It approaches *pullus* in coloration.

Specimens examined.—Eight skins and nine skulls, all from San Francisco Island.

The pocket mice that are now known to inhabit the islands of the Gulf of California, Mexico, are as follows:

Perognathus baileyi insularis Townsend. Tiburón Island, Sonora.

Perognathus baileyi fornicatus Burt. Monserrate Island, Lower California.

Perognathus penicillatus seri Nelson. Tiburón Island, Sonora.

Perognathus penicillatus minimus Burt. Turner's Island, Sonora.

Perognathus arenarius siccus Osgood. Ceralbo Island, Lower California.

Perognathus spinatus evermanni Nelson and Goldman. Mejía Island, Lower California.

Perognathus spinatus guardiae Burt. Angel de la Guardia Island, Lower California.

Perognathus spinatus marcosensis Burt. San Marcos Island, Lower California.

Perognathus spinatus pullus Burt. Coronados Island (Gulf side), Lower California.

Perognathus spinatus occultus Nelson. Carmen Island, Lower California.

Perognathus spinatus seorsus Burt. Danzante Island, Lower California.

Perognathus spinatus bryanti Merriam. San José Island, Lower California.

Perognathus spinatus latijugularis Burt. San Francisco Island, Lower California.

Perognathus spinatus lambi Benson. Espíritu Santo Island, Lower California.

A table of measurements of all these forms is given on the next page.

MINIMUM, MAXIMUM AND AVERAGE MEASUREMENTS IN MILLIMETERS OF *Perognathus* FROM THE GULF OF CALIFORNIA

	No. Specimens	Total Length	Tail Vertebrae	Hind Foot	Greatest Length of Skull	Basal Length (groove on incisor to condyle)	Greatest Mastoid Breadth	Length of Mastoids	Interorbital Constriction	Length of Nasals	Interparietal Length	Interparietal Width	Length of Maxillary Tooth Row
P. b. insularis	8	202 (185-211)	115 (103-123)	26 (24-27)	28.2 (27.2-29.3)	23.6 (22.7-24.5)	14.4 (13.8-15.1)	9.4 (9.2-9.7)	6.7 (6.2-7.1)	10.9 (10.6-12.0)	4.1 (3.5-4.4)	6.7 (6.4-7.0)	4.0 (3.8-4.2)
P. b. fornicatus	10	192 (179-202)	102 (94-109)	26 (25-27)	28.5 (27.9-29.1)	23.9 (23.4-24.6)	14.3 (14.1-14.5)	8.9 (8.3-9.2)	6.5 (6.3-6.9)	10.9 (10.1-11.4)	3.6 (3.4-3.9)	6.4 (6.1-6.6)	4.3 (4.0-4.4)
P. b. extimus	6	201 (188-223)	111 (103-124)	25 (24-27)	29.3 (28.5-30.7)	24.9 (24.2-26.7)	15.2 (14.7-15.8)	9.5 (9.3-10.2)	6.9 (6.8-7.0)	11.6 (10.1-12.5)	4.0 (3.7-4.3)	6.1 (5.8-6.3)	4.1 (4.0-4.4)
P. p. seri	18	171 (161-195)	98 (92-106)	23 (22-24)	24.3 (23.1-25.6)	20.2 (19.3-21.0)	13.1 (12.1-13.0)	7.8 (7.4-8.1)	5.9 (5.5-6.3)	9.0 (8.4-9.7)	3.5 (2.9-4.0)	6.6 (6.0-7.2)	3.5 (3.3-3.8)
P. p. minimus	1	162	97	20	23.9	19.5	12.5	7.1	6.2	9.2	3.6	7.1	3.5
P. s. evermanni	4	151 (144-155)	79 (76-82)	21 (20-21)	23.9 (23.2-24.8)	19.8 (19.4-20.4)	11.8 (11.7-11.9)	6.7 (6.6-6.8)	5.8 (5.8-5.9)	9.3 (8.8-9.4)	3.3 (3.1-3.5)	7.4 (7.3-7.5)	3.5 (3.4-3.6)
P. s. guardiae	36	161 (140-175)	87 (75-96)	22.5 (20-23)	24.6 (23.3-26.2)	20.2 (18.8-21.4)	12.1 (11.3-12.7)	6.9 (6.4-7.3)	6.0 (5.6-6.5)	9.8 (8.6-10.6)	3.0 (2.6-3.5)	7.1 (6.4-7.6)	3.7 (3.5-4.1)
P. s. marcosensis	17	168 (150-178)	97 (88-103)	21 (21-22)	24.4 (22.2-25.5)	20.0 (18.5-20.5)	11.9 (11.4-12.5)	7.0 (6.4-7.5)	6.1 (5.6-6.4)	9.3 (8.2-10.0)	3.6 (3.4-3.8)	7.1 (6.7-7.5)	3.6 (3.4-3.8)
P. s. pullus	7	183 (170-192)	104 (96-111)	23 (22-23)	25.8 (25.1-26.5)	21.3 (20.5-22.2)	12.7 (12.6-12.9)	7.3 (6.9-7.6)	6.4 (6.2-6.5)	10.3 (9.9-10.8)	3.9 (3.7-4.1)	7.8 (7.6-8.0)	3.5 (3.4-3.7)
P. s. occultus	5	182 (168-205)	100 (90-115)	22 (21-23)	25.5 (23.3-27.3)	20.9 (19.1-22.4)	12.6 (11.7-13.0)	7.2 (6.5-7.9)	6.5 (6.1-6.8)	9.8 (8.9-10.5)	3.8 (3.6-4.0)	7.6 (7.5-7.7)	3.9 (3.6-4.0)
P. s. seorsus	7	181 (167-196)	103 (98-111)	23 (22-24)	25.1 (24.5-25.7)	21.0 (20.4-21.4)	12.3 (12.0-12.4)	7.2 (7.0-7.4)	6.5 (6.3-7.1)	9.8 (9.0-10.6)	3.6 (3.5-3.6)	7.3 (6.9-7.6)	3.7 (3.6-3.8)
P. s. bryanti	23	190 (166-203)	113 (88-125)	24 (23-25)	25.5 (24.1-26.7)	21.0 (19.8-22.0)	12.7 (12.2-13.5)	7.7 (7.1-8.2)	6.7 (6.3-7.4)	10.1 (9.2-11.4)	3.9 (3.4-4.4)	7.7 (6.9-8.4)	3.6 (3.4-3.9)
P. s. latijugularis	9	179 (170-188)	106 (100-110)	22 (22-22)	25.5 (24.2-26.8)	21.1 (20.4-22.0)	12.6 (12.2-12.9)	7.5 (7.2-7.8)	6.7 (6.5-7.0)	9.5 (9.0-10.3)	3.6 (3.5-3.7)	7.3 (6.9-7.5)	3.9 (3.6-4.0)
P. s. lambi	8	175 (163-187)	99 (89-107)	23 (22-24)	25.7 (25.1-26.6)	21.1 (20.6-21.5)	12.2 (11.9-12.7)	7.0 (6.6-7.2)	6.8 (6.2-7.1)	10.2 (9.8-11.0)	3.2 (3.1-3.3)	7.5 (7.1-8.0)	3.7 (3.4-3.9)

Genus **PEROMYSCUS.** WHITE-FOOTED MICE

Peromyscus sejugis sp. nov.

SANTA CRUZ ISLAND MOUSE

Type.—Male adult, skull and skin; no. 50,632, collection of California Institute of Technology; Santa Cruz Island (latitude 25° 17′ N., longitude 110° 43′ W.), Gulf of California, Lower California, Mexico; January 23, 1932; collected by W. H. Burt; original no. 3530.

Measurements.—Type: Total length, 187 mm.; tail vertebrae, 89; hind foot, 23; ear from crown, 16. Skull: greatest length, 27.3; condylo-basal length, 25.0; basilar length of Hensel, 21.7; zygomatic breadth, 14.0; interorbital constriction, 4.0; interparietal, 8.8 x 2.7; length of nasals, 11.0; shelf of bony palate, 4.3; maxillary tooth row, 4.1. Averages of 24 specimens from Santa Cruz Island—Body: 173; 85; 22; 16. Skull: 26.3; 23.8; 20.4; 13.1; 4.0; 8.7 x 2.8; 10.4; 4.1; 3.9.

Distribution.—Known from Santa Cruz and San Diego Islands, Gulf of California, Mexico.

Characters.—A large insular *Peromyscus* whose affinities are with the *maniculatus* group of mice. Color of upperparts grayish washed with "avellaneous," giving a general dull color to upperparts; underparts white; tail distinctly bi-color with narrow dorsal stripe (about 1.5 mm. wide in dry skin); ears dusky. Skull arched antero-posteriorly; rostrum heavy; nasals broad, tapering posteriorly and terminating beyond premaxillae; audital bullae relatively small; length of shelf of bony palate greater than length of maxillary tooth row.

Remarks.—Peromyscus sejugis, the only mammal known to inhabit Santa Cruz and San Diego Islands, is somewhat larger than *Peromyscus maniculatus coolidgei* Thomas from the peninsula. It is clearly a member of the *maniculatus* group and, as is also the case on other of the gulf islands where but one species occupies a small island, has developed to large size. Specimens from San Diego Island (latitude 25° 12′ N., longitude 110° 42′ W.) vary slightly from the Santa Cruz Island specimens in that the nasals are less tapering and the sutures between the frontals and the parietals form more of an angle in the median line. There is some overlapping in these characters, however, and it is thought advisable for the present not to separate them by name.

Specimens examined.—Thirty-two from Santa Cruz Island and nine from San Diego Island.

Peromyscus boylii glasselli subsp. nov.

GLASSELL WHITE-FOOTED MOUSE

Type.—Male adult, skull and skin; no. 50,349, collection of California Institute of Technology; San Pedro Nolasco Island (latitude 27° 58′ N., longitude 111° 24′ W.), Gulf of California, Sonora, Mexico; December 26, 1931; collected by W. H. Burt; original no. 3247.

Measurements.—Type: Total length, 188 mm.; tail vertebrae, 97; hind foot,

23; ear from crown, 16. Skull: greatest length, 26.5; condylo-basal length, 23.6; basilar length of Hensel, 20.2; zygomatic breadth, 13.1; interorbital constriction, 4.0; interparietal, 9.4 x 3.5; length of nasals, 10.6; shelf of bony palate, 3.6; maxillary tooth row, 4.2.

Distribution.—Known only from San Pedro Nolasco Island, Gulf of California, Mexico.

Characters.—An insular race of the *Peromyscus boylii* group of mice. Similar to *Peromyscus boylii rowleyi* (Allen) in size; color of upperparts duller and paler than in *rowleyi;* underparts white with a "vinaceous-buff" pectoral spot; ears dusky, contrasting slightly with color of upperparts. Skull similar to that of *rowleyi,* but differs in broader rostrum, more pointed nasals at posterior termination and more rounded braincase.

Remarks.—I have not seen specimens of *Peromyscus boylii spicilegus* Allen from southern Sonora, but according to Osgood (North Amer. Fauna, no. 28, p. 149, 1909) *spicilegus* is larger and more richly colored than *rowleyi* which would also distinguish it from *glasselli.*

This race is named for Mr. Steve Glassell, a member of the party on board Mr. Pemberton's boat, whose assistance aided to no small degree in the collecting of a number of the island forms.

Specimens examined.—Seven, all from San Pedro Nolasco Island.

Peromyscus collatus sp. nov.

Turner's Island Canyon Mouse

Type.—Female adult, skull and skin; no. 50,432, collection of California Institute of Technology; Turner's Island (latitude 28° 43′ N., longitude 112° 19′ W.), Gulf of California, Sonora, Mexico; December 31, 1931; collected by W. H. Burt; original no. 3330.

Measurements.—Type: Total length, 170 mm.; tail vertebrae, 90; hind foot, 20; ear from crown, 15. Skull: greatest length, 23.9; condylo-basal length, 21.0; basilar length of Hensel, 17.5; zygomatic breadth, 12.0; interorbital constriction, 3.9; interparietal, 8.0 x 3.2; length of nasals, 8.5; shelf of bony palate, 4.0; maxillary tooth row, 3.5. Averages of ten adults—Body: 174; 94; 20; 15. Skull: 24.0; 21.3; 17.7; 12.3; 3.9; 8.3 x 2.9; 8.7; 3.9; 3.5.

Distribution.—Known only from Turner's Island, Gulf of California, Mexico.

Characters.—A member of the *Peromyscus crinitus* group of mice. Externally similar to *Peromyscus eremicus tiburonensis* Mearns especially in coloration and pelage; color darker and richer than in *Peromyscus crinitus stephensi* Mearns; size about as in *tiburonensis* and *stephensi.* Skull with zygomata compressed anteriorly; rostrum depressed, short, and broad; first and second upper molars with rudimentary accessory tubercles between outer primary tubercles as in

stephensi, but differing from that form in broader, shorter rostrum with the correlated broad incisors, and in having somewhat less inflated audital bullae.

Remarks.—The Turner's Island mouse combines the characters of *crinitus* and *eremicus* by showing a striking resemblance externally to members of the species *eremicus*, especially in the scantily haired tail, and in having the skull characters of *crinitus*.

Specimens examined.—Nineteen, all from Turner's Island.

Peromyscus pseudocrinitus sp. nov.

CORONADOS ISLAND CANYON MOUSE

Type.—Male adult, skull and skin; no. 50,333, collection of California Institute of Technology; Coronados Island (latitude 26° 06′ N., longitude 111° 18′ W.), Gulf of California, Lower California, Mexico; December 20, 1931; collected by W. H. Burt; original no. 3231.

Measurements.—Type: Total length, 191 mm.; tail vertebrae, 105; hind foot, 21; ear from crown, 17. Skull: greatest length, 25.6; condylo-basal length, 23.2; basilar length of Hensel, 19.7; zygomatic breadth, 12.5; interorbital constriction, 4.2; interparietal, 8.6 x 3.1; length of nasals, 9.0; shelf of bony palate, 3.5; maxillary tooth row, 3.8. Averages of six adults—Body: 194; 110; 21; 16. Skull: 25.3; 23.0; 19.4; 12.7; 4.2; 8.6 x 2.9; 9.3; 3.4; 3.8.

Distribution.—Known only from Coronados Island (Gulf side), Gulf of California, Mexico.

Characters.—An extremely dark-colored *Peromyscus* (darkest of the gulf island forms) with long, scantily haired tail which is indistinctly bi-color on the proximal two-thirds. Color of upperparts "plumbeous-black" washed with "cinnamon;" underparts white. Skull in general outline similar to that of *crinitus*, but larger and with relatively less inflated audital bullae; nasals broad, parallel-sided, and bluntly rounded at posterior termination; premaxillae extend slightly beyond nasals; accessory tubercles between outer primary tubercles in first and second upper molars present and more prominent than in *crinitus;* shelf of bony palate shorter than length of maxillary tooth row; interparietal divided in four out of seven specimens.

Remarks.—This species is quite distinct from any other known form of *Peromyscus*. It seems to combine the characters of the subgenus *Haplomylomys* with those of *Peromyscus* even more so than does *crinitus* in that the external characters are truly suggestive of the *eremicus* type of mouse, but the teeth are of the type found in the subgenus *Peromyscus*. Its closest relative seems to be *collatus* from Turner's Island, however, *pseudocrinitus* differs from *collatus* in larger size, darker coloration, broader nasals which do not taper posteriorly, and in having the shelf of the bony palate shorter than the maxillary tooth row rather than longer as in *collatus*.

Specimens examined.—Seven, all from Coronados Island.

Peromyscus caniceps sp. nov.

MONSERRATE ISLAND CANYON MOUSE

Type.—Male adult, skull and skin; no. 50,273, collection of California Institute of Technology; Monserrate Island (latitude 25° 38′ N., longitude 111° 02′ W.), Gulf of California, Lower California, Mexico; December 16, 1931; collected by W. H. Burt; original no. 3171.

Measurements.—Type: Total length, 199 mm.; tail vertebrae, 111; hind foot, 21; ear from crown, 15. Skull: greatest length, 25.6; condylo-basal length, 22.6; basilar length of Hensel, 19.4; zygomatic breadth, 13.3; interorbital constriction, 4.0; interparietal, 9.3 x 4.0; length of nasals, 9.5; shelf of bony palate, 4.2; maxillary tooth row, 3.7. Averages of sixteen adults—Body: 202; 112; 22; 15.5. Skull: 25.7; 22.9; 19.5; 13.2; 4.0; 9.3 x 4.0; 9.4; 4.0; 3.8.

Distribution.—Known only from Monserrate Island, Gulf of California, Mexico.

Characters.—A *Peromyscus* of the *eremicus* type. Back and sides heavily washed with "ochraceous-buff;" head grayish, contrasting with back and sides; lateral line indistinct; underparts white washed with buff (in some specimens the "ochraceous-buff" of the sides continues ventrally, with no break at the lateral line region, and covers the entire ventral surface except the throat and chin); tail indistinctly bi-color, dusky above, whitish below; ears dusky; young of the species grayish throughout. Skull more angular than in *pseudocrinitus;* zygomatic process of squamosal projects laterally noticeably beyond border of brain case, arches taper anteriorly; first and second upper molars with accessory tubercles in thirteen out of twenty specimens; shelf of bony palate longer than maxillary tooth row; audital bullae small; nasals taper slightly posteriorly.

Remarks.—Although similar in some respects and undoubtedly belonging to the same group as *pseudocrinitus, caniceps* appears to be a distinct species. It not only differs radically in coloration from *pseudocrinitus,* but the skull is also distinct with its wide-spreading zygomatic processes of the squamosal, its tapering nasals, and the relative length of the shelf of the bony palate and the maxillary tooth row.

Specimens examined.—Twenty, all from Monserrate Island.

Peromyscus guardia mejiae subsp. nov.

MEJIA ISLAND MOUSE

Type.—Male adult, skull and skin; no. 50,473, collection of California Institute of Technology; Mejía Island (latitude 29° 33′ N., longitude 113° 35′ W.), Gulf of California, Lower California, Mexico; January 7, 1932; collected by W. H. Burt; original no. 3371.

Measurements.—Type: Total length, 216 mm.; tail vertebrae, 122; hind foot, 23; ear from crown, 17. Skull: greatest length, 27.1; condylo-basal length, 24.4; basilar length of Hensel, 21.0; zygomatic breadth, 12.2; interorbital con-

striction, 4.1; interparietal, 8.0 x 3.1; length of nasals, 9.9; shelf of bony palate, 4.6; maxillary tooth row, 3.9.

Distribution.—Known only from Mejía Island, Gulf of California, Mexico.

Characters.—Similar to *Peromyscus guardia guardia* Townsend from Angel de la Guardia Island but slightly larger and distinctly darker in coloration. Color of upperparts dusky with an indication of "light vinaceous-cinnamon" interspersed among the dusky hairs, in *guardia* the "light vinaceous-cinnamon" predominates on the dorsal surface; lateral line of "light vinaceous-cinnamon" indistinct, the color continuing to ventral surface, contrasting with the white ventral surface of *guardia.* Skull longer and narrower than that of *guardia,* but very similar in other respects.

Remarks.—The narrow channel separating Mejía Island from Angel de la Guardia Island has apparently been an effective barrier to the two races of mice inhabiting the respective islands.

Specimens examined.—Two from Mejía Island.

Peromyscus guardia interparietalis subsp. nov.

SAN LORENZO ISLAND MOUSE

Type.—Male adult, skull and skin; no. 50,562, collection of California Institute of Technology; South San Lorenzo Island (latitude 28° 36′ N., longitude 112° 51′ W.), Gulf of California, Lower California, Mexico; January 11, 1932; collected by W. H. Burt; original no. 3460.

Measurements.—Type: Total length, 207 mm.; tail vertebrae, 116; hind foot, 22; ear from crown, 18. Skull: greatest length, 26.3; condylo-basal length, 24.0; basilar length of Hensel, 20.4; zygomatic breadth, 13.4; interorbital constriction, 4.0; interparietal, 9.0 x 2.6; length of nasals, 10.0; shelf of bony palate, 4.1; maxillary tooth row, 4.3. Averages of five adults—Body: 200; 110; 22; 18. Skull: 26.1; 23.6; 20.1; 13.2; 4.0; 9.1 x 2.7; 9.7; 3.9; 4.0.

Distribution.—Known only from South San Lorenzo Island, Gulf of California, Mexico.

Characters.—Similar in size and coloration to *guardia,* but hind foot smaller and tail shorter. Skull differs from that of *guardia* in narrower interpterygoid fossa, shorter shelf of bony palate with incisive foramina reaching plane of first molars, and in a longer narrower interparietal. In *guardia* the interparietal does not reach the suture between the parietal and the squamosal whereas in *interparietalis* it does. From *mejiae, interparietalis* differs, in addition to the difference pointed out between *guardia* and *interparietalis*, in smaller size and paler coloration. Differs from *Peromyscus stephani* Townsend from San Estéban Island chiefly in longer tail, larger audital bullae, and coloration which is less grayish and has more of the "light vinaceous-cinnamon" overwash.

Remarks.—The chain of islands from Mejía on the north to South San Lorenzo on the south forms a rather close group and it is not surprising to find closely related species of mammals on the islands of this chain. The *guardia* group of *Peromyscus* seems to be distinct from other members of the subgenus

Haplomylomys. They are large-bodied forms with characteristic skulls which are rather difficult to describe, but which, when placed in series, fall into a group of their own and not with other members of the subgenus. *Peromyscus stephani* falls in with this group also.

Specimens examined.—Eight, all from South San Lorenzo Island.

Peromyscus dickeyi sp. nov.

Tortuga Island Mouse

Type.—Male adult, skull and skin; no. 18,100, collection of Donald R. Dickey; Tortuga Island (latitude 27° 21′ N., longitude 111° 54′ W.), Gulf of California, Lower California, Mexico; April 2, 1930; collected by H. H. Sheldon; original no. 6378.

Measurements.—*Type*: Total length, 185 mm.; tail vertebrae, 82; hind foot, 23; ear from notch, 18. Skull: greatest length, 26.8; condylo-basal length, 24.8; basilar length of Hensel, 21.5; zygomatic breadth, 13.8; interorbital constriction, 4.0; interparietal, 8.4 x 3.6; length of nasals, 9.8; shelf of bony palate, 4.4; maxillary tooth row, 4.6. Averages of seventeen adults—Body: 191; 91; 22; 20. Skull: 26.6; 24.3; 20.8; 13.6; 4.0; 8.6 x 3.1; 9.8; 4.2; 4.5.

Distribution.—Known only from Tortuga Island, Gulf of California, Mexico.

Characters.—A large-bodied, short-tailed mouse of the subgenus *Haplomylomys*. Color of upperparts (worn pelage) dusky washed with "pinkish cinnamon;" ears dusky, lateral line present; soles of hind feet naked; tail bi-color; underparts white with a faint pectoral spot, in some specimens, of "pinkish cinnamon." Young individuals and adults in the new pelage have the entire underparts washed with "pinkish cinnamon." June specimens in new unworn pelage are darker and more grayish than specimens in the worn pelage. Young individuals are dark gray in color. Skull broad and squarely built; zygomatic arches nearly parallel-sided; rostrum heavy; nasals wide anteriorly; premaxillae project well beyond posterior limits of nasals; incisors heavy; audital bullae small; lower jaw heavy, nearly as large as in *Peromyscus californicus insignis* Rhoads; ridges for muscle attachments prominent.

Remarks.—*Peromyscus dickeyi* represents a form quite distinct from any of the known species of the subgenus *Haplomylomys*, being the only member which has a tail decidedly shorter than the head and body.

The species is named for the late Donald R. Dickey who collected the first series on the island and whose interest made possible the work in the gulf region.

Specimens examined.—Thirty-eight skins (ten young) and forty-two skulls, all from Tortuga Island.

Peromyscus pembertoni sp. nov.

Pemberton Mouse

Type.—Male adult, skull and skin; no. 50,347, collection of California Institute of Technology; San Pedro Nolasco Island (latitude 27° 58′ N., longi-

tude 111° 24′ W.), Gulf of California, Sonora, Mexico; December 26, 1931; collected by W. H. Burt; original no. 3245.

Measurements.—Type: Total length, 210 mm.; tail vertebrae, 100; hind foot, 24; ear from crown, 18. Skull: greatest length, 27.5; condylo-basal length, 25.3; basilar length of Hensel, 21.5; zygomatic breadth, 14.7; interorbital constriction, 4.0; interparietal, 9.6 x 3.2; length of nasals, 10.4; shelf of bony palate, 4.8; maxillary tooth row, 4.4. Averages of ten adults—Body: 208; 103; 24; 18. Skull: 27.3; 25.1; 21.5; 14.5; 4.0; 9.3 x 2.9; 10.1; 4.7; 4.3.

Distribution.—Known only from San Pedro Nolasco Island, Gulf of California, Mexico.

Characters.—A large-bodied, short-tailed member of the subgenus *Haplomylomys*, apparently most closely related to *dickeyi* from Tortuga Island. Color of upperparts "light vinaceous-cinnamon" lightly mixed with fine dusky lines on back, noticeably paler than *dickeyi;* head somewhat paler than back; tail bi-color, brownish above, white below; underparts white; young individuals pale slate gray; length of tail about equal to head and body. Skull distinct; most similar to that of *dickeyi*, but larger and heavier; zygomatic arches taper anteriorly; sutures between frontals and parietals form an acute angle in median line; interparietal narrow antero-posteriorly; rostrum heavy as in *dickeyi;* premaxillae extend beyond nasals. *Peromyscus pembertoni* may be distinguished from all members of the subgenus *Haplomylomys* except *dickeyi* by its relatively short tail.

Remarks.—San Pedro Nolasco Island is the only island in the gulf that is known to support two species of *Peromyscus,* the other being *Peromyscus boylii glasselli.* No other mammals were found on the island.

The species is named for Mr. J. R. Pemberton in slight recognition of his whole-hearted support in obtaining specimens from many of the inaccessible islands in the Gulf of California.

Specimens examined.—Twelve, all from San Pedro Nolasco Island.

The white-footed mice that are now known to inhabit the islands of the Gulf of California, Mexico, are as follows:

Peromyscus sejugis Burt. Santa Cruz and San Diego Islands, Lower California.

Peromyscus boylii glasselli Burt. San Pedro Nolasco Island, Sonora.

Peromyscus crinitus pallidissimus Huey. Small unnamed island in Gonzaga Bay, Lower California.

Peromyscus collatus Burt. Turner's Island, Sonora.

Peromyscus pseudocrinitus Burt. Coronados Island (Gulf side), Lower California.

Peromyscus caniceps Burt. Monserrate Island, Lower California.

Peromyscus eremicus tiburonensis Mearns. Tiburón Island, Sonora.

Peromyscus eremicus carmeni Townsend. Carmen Island, Lower California.

Peromyscus eremicus cinereus Hall. San José Island, Lower California.

Peromyscus eremicus insulicola Osgood. Espíritu Santo Island, Lower California.

Peromyscus eremicus avius Osgood. Ceralbo Island, Lower California.

Peromyscus guardia guardia Townsend. Angel de la Guardia Island, Lower California.

Peromyscus guardia mejiae Burt. Mejía Island, Lower California.

Peromyscus guardia interparietalis Burt. South San Lorenzo Island, Lower California.

Peromyscus stephani Townsend. San Estéban Island, Sonora.

Peromyscus dickeyi Burt. Tortuga Island, Lower California.

Peromyscus pembertoni Burt. San Pedro Nolasco Island, Sonora.

Genus NEOTOMA. Wood Rats

Neotoma varia sp. nov.

Turner's Island Wood Rat

Type.—Female adult, skull and skin; no. 50,425, collection of California Institute of Technology; Turner's Island (latitude, 28° 43′ N., longitude, 112° 19′ W.), Gulf of California, Sonora, Mexico; December 31, 1931; collected by W. H. Burt; original no. 3323.

Measurements.—Type: Total length, 305 mm.; tail vertebrae, 140; hind foot, 33; ear from crown, 25. Skull: basilar length of Hensel, 34.3; zygomatic breadth, 22.7; interorbital constriction, 5.9; length of nasals, 16.0; length of incisive foramina, 8.5; length of palatal bridge, 6.3; maxillary tooth row, 8.0.

Distribution.—Known only from Turner's Island, Gulf of California, Mexico.

Characters.—A small, short-tailed wood rat of the *Neotoma albigula* group (see Goldman, North Amer. Fauna, no. 31, p. 14, 1910) with heavy rostrum and short palatal bridge. Similar in coloration to *Neotoma albigula albigula* Hartley but with less of the pinkish buff, especially on the cheeks. Differs from *albigula* otherwise in relatively heavier rostrum with incisors more incurved; broader nasals at posterior termination, shorter palatal bridge, lighter pterygoids, and more rounded, less prominent coronoid process. Differs from *Neotoma albigula seri* Townsend, in addition to the characters pointed out above for *albigula*, in paler coloration of dorsal surface of tail, brownish instead of blackish,

and in smaller size and shorter tail. The skull is also more arched antero-posteriorly on the dorsal surface. Differs from *Neotoma albigula melanura* Merriam and *Neotoma albigula sheldoni* Goldman chiefly in smaller size and paler coloration throughout.

The one specimen of *varia* available differs also from specimens representing the races mentioned above in the shape of the maxillary tooth rows and in the structure of the last upper molar. In all the specimens of *albigula, seri, melanura,* and *sheldoni* examined the outer border of the maxillary tooth row forms a nearly straight line whereas in *varia* the outer border is distinctly convex. The last upper molar in *varia* differs from that of all the others examined in having but two lobes with one external reentrant angle instead of three lobes with two external reentrant angles. Whether this is an abnormal condition present in the one specimen available or whether it is a constant character will not be known until more specimens are obtained from Turner's Island. This is not, however, a condition of an old individual with extremely worn teeth. In cases where the tooth is worn down nearly to the cingulum the pattern is often somewhat changed, but the teeth in this particular specimen are still relatively high crowned and unworn.

It is thought advisable, for the present at least, to give full specific designation to the Turner's Island Wood Rat because of the relative constancy in tooth pattern in the genus *Neotoma* and because of this marked divergence from specimens of *Neotoma albigula.*

Remarks.—Although wood rat nests were found to be common on Turner's Island, and some twenty traps were set, only one specimen was taken. The nests were built on the ground among cactus and brush.

Specimen examined.—One, the type.

Neotoma lepida marcosensis subsp. nov.

SAN MARCOS ISLAND WOOD RAT

Type.—Male adult, skull and skin; no. 50,600, collection of California Institute of Technology; San Marcos Island (latitude 27° 13′ N., longitude, 112° 05′ W.), Gulf of California, Lower California, Mexico; January 18, 1932; collected by W. H. Burt; original no. 3498.

Measurements.—Type: Total length, 380 mm.; tail vertebrae, 163; hind foot, 39; ear from crown, 31. Skull: basilar length of Hensel, 39.5; zygomatic breadth, 24.7; interorbital constriction, 6.0; length of nasals, 19.7; length of incisive foramina, 10.1; length of palatal bridge, 8.3; maxillary tooth row, 9.2.

Distribution.—Known only from San Marcos Island, Gulf of California, Mexico.

Characters.—A large, dark-colored wood rat of the *Neotoma lepida* group (see Goldman, Jour. Mammalogy, 13, 59-67, February, 1932). Coloration of upperparts grayish buff, back much darkened by black-tipped hairs; sides paler than back; a patch of buffy extending from beneath anterior portion of eye to ear; nose grayish; ears fuscous; underparts whitish, hairs plumbeous at bases except

for a pure white patch between front legs and another between hind legs, and in some cases a white streak down the mid-ventral line; tail blackish above, white below. Skull large and angular; supraorbital ridges prominent; interpterygoid fossa relatively wide; audital bullae medium.

Differs from *Neotoma lepida felipensis* Elliot from the mainland and *Neotoma lepida insularis* Townsend from Angel de la Guardia Island in larger size and darker coloration; also larger and darker than *Neotoma lepida perpallida* Goldman from San José Island or *Neotoma lepida abbreviata* Goldman from San Francisco Island; bullae larger and dentition heavier than either *Neotoma lepida vicina* Goldman from Espíritu Santo Island or *Neotoma lepida arenacea* Allen from the Cape Region.

The closest relative of *marcosensis,* as far as can be discerned from the available material, is *Neotoma lepida nudicauda* Goldman from Carmen Island, However, *marcosensis* differs from *nudicauda* in darker, less buffy coloration, the absence of the buffy lateral pectoral spots, the presence of a clear white pectoral spot, wider interpterygoid fossa, and smaller antorbital foramina.

Remarks.—This race, largest of the insular races of the *Neotoma lepida* group, occupies the rocky canyons of the island where it builds nests among the large boulders and cactus plants.

Specimens examined.—Nine, all from San Marcos Island.

Neotoma lepida latirostra subsp. nov.

Danzante Island Wood Rat

Type.—Female adult, skull and skin; no. 50,308, collection of California Institute of Technology; Danzante Island (latitude, 25° 47′ N., longitude, 111° 11′ W.), Gulf of California, Lower California, Mexico; December 17, 1931; collected by W. H. Burt; original no. 3206.

Measurements.—Type: Total length, 365 mm.; tail vertebrae, 158; hind foot, 38; ear from crown, 27. Skull: basilar length of Hensel, 37.5; zygomatic breadth, 23.2; interorbital constriction, 5.5; length of nasals, 17.9; length of incisive foramina, 9.4; length of palatal bridge, 7.8; maxillary tooth row, 9.1.

Distribution.—Known only from Danzante Island, Gulf of California, Mexico.

Characters.—A moderately large wood rat of the *lepida* group with broad, heavy rostrum, heavy dentition, large rounded bullae, and relatively short tail. Coloration similar to that of *arenacea*, but differs from that form in relatively shorter tail, heavier dentition, narrower interpterygoid space, longer palatal bridge, shorter incisive foramina, broader rostrum, and longer nasals. Differs from *perpallida* in larger size, relatively shorter tail, darker coloration, heavier dentition, broader rostrum, and larger audital bullae. Differs from *nudicauda* in darker coloration, larger size, heavier rostrum, and less trenchant supraorbital ridges. Also the supraoccipital, when skull is viewed from above, rises abruptly in *latirostra* whereas in *nudicauda* it slopes forward. Differs from *marcosensis* in lighter, more buffy coloration, shorter tail, lighter dentition, broader rostrum,

and more highly arched skull with less backward projection of occipital condyles.

Remarks.—The type and only specimen taken was run out of a nest built on the ground in a thicket at the edge of a small canyon. She had three embryos in her uterus.

Specimen examined.—One, the type.

Neotoma bunkeri sp. nov.

CORONADOS ISLAND WOOD RAT

Type.—Male adult, skull and skin; no. 50,315, collection of California Institute of Technology; Coronados Island (latitude, 26° 06′ N., longitude, 111° 18′ W.), Gulf of California, Lower California, Mexico; December 20, 1931; collected by W. H. Burt; original no. 3213.

Measurements.—Type: Total length, 390 mm.; tail vertebrae, 168; hind foot, 43; ear from crown, 32. Skull: basilar length of Hensel, 39.5; zygomatic breadth, 25.3; interorbital constriction, 6.0; length of nasals, 19.5; length of incisive foramina, 10.7; length of palatal bridge, 7.5; maxillary tooth row, 9.7.

Distribution.—Confined, as far as known, to Coronados Island (Gulf side), Gulf of California, Mexico.

Characters.—A medium-sized, dark-colored wood rat of the *Neotoma fuscipes* group, subgenus *Homodontomys,* (see Goldman, North Amer. Fauna, no. 31, p. 86, 1910). Hairs of upperparts deep mouse gray at bases followed by a band of vinaceous buff with black tips, giving a dark gray general appearance to upperparts; underparts deep mouse gray washed with white; tail brownish above, white below; soles of hind feet naked to heel. Skull similar to that of *Neotoma fuscipes macrotis* Thomas but with relatively shorter and broader rostrum, wider antorbital foramina, less rounded audital bullae, and more flattened braincase. The broad third upper molar with four enamel loops definitely places this species in the subgenus *Homodontomys.*

Remarks.—The poorly constructed stick houses of these rats were found commonly among the dark lava boulders and cactus on Coronados Island. This is the only known insular member of the *fuscipes* group of wood rats and its presence on Coronados Island indicates that the former range of the group probably extended much farther south in Lower California than it does at the present time. The southern limit of the range of the group as given by Goldman (*ibid.* p. 88, fig. 13) was at about 30° north latitude along the west coast of Lower California. The extremely dark coloration of *bunkeri* "fits in" with the general color of the background of the island which is made up almost exclusively of dark colored lava.

It is a pleasure to name this well differentiated island species for Mr. Charles D. Bunker in personal gratitude and in recognition of the inspiration he has been to those students of natural history who have been privileged to work with and learn from him.

Specimens examined.—Ten, all from Coronados Island.

Certain of the insular forms of the *Neotoma lepida* group have been considered as distinct species (see Goldman, Jour. Mammalogy, 13, 65-66, February, 1932). With sufficient material of all of the island representatives as well as those on the adjoining mainland the close relationships of the various forms are clearly indicated. It seems that the primary purpose of systematic studies—the outlining of true relationships and natural groupings—is defeated when slightly differentiated insular forms are given full specific rank chiefly because there is no present geographic intergradation with other insular forms or with those on the mainland. In connection with the present paper particular attention was given to a series each of *abbreviata* and *nudicauda* from San Francisco Island and Carmen Island respectively. Goldman (North Amer. Fauna, no. 31, pp. 49-51, 1910) treated these as distinct species, *abbreviata* because of its small size and short tail. He suggests the close relationship with the *lepida* group when in speaking of *abbreviata* he says, "Although clearly a member of the *intermedia* [*lepida*] group, this small insular wood rat is a distinct species, separable from its nearer relatives by small size and abbreviated tail." As a matter of fact a series of nine specimens of *abbreviata* at hand have an average tail length which is 45 per cent of the average total length whereas a series of seven specimens of *perpallida* from San José Island have an average tail length which is 49 per cent of the average total length—a difference of four per cent which is insignificant when one considers the variation in the group. These island forms of the *lepida* group were undoubtedly derived from the same ancestral stock and have developed along slightly different lines subsequent to isolation. It therefore seems more logical to emphasize their natural relationships by treating them as races of one species. Accordingly, *abbreviata, nudicauda,* and *insularis* are treated as subspecies in the present paper.

The wood rats that are now known to inhabit the islands of the Gulf of California, Mexico, are as follows:

Neotoma albigula seri Townsend. Tiburón Island, Sonora.

Neotoma varia Burt. Turner's Island, Sonora.

Neotoma lepida insularis Townsend. Angel de la Guardia Island, Lower California.

Neotoma lepida marcosensis Burt. San Marcos Island, Lower California.

Neotoma lepida nudicauda Goldman. Carmen Island, Lower California.

Neotoma lepida latirostra Burt. Danzante Island, Lower California.

Neotoma lepida perpallida Goldman. San José Island, Lower California.

Neotoma lepida abbreviata Goldman. San Francisco Island, Lower California.

Neotoma lepida vicina Goldman. Espíritu Santo Island, Lower California.

Neotoma bunkeri Burt. Coronados Island, Lower California.

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TRANSACTIONS

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A SOUTHERN RACE OF THE SPOTTED SCREECH OWL

BY

A. J. van Rossem

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Scops trichopsis was described by Johann Georg Wagler[1] from a specimen in the Würzburg Museum. This bird was part of a collection made by Dr. Petz somewhere in Mexico but the exact locality appears to be unknown. However, since the collection contained such other species as *Glaucidium gnoma* [*Glaucidium minutissimum gnoma*], *Callipepla strenua* [*Callipepla squamata squamata*], *Odontophorus meleagris* [*Cyrtonyx montezumae montezumae*], and *Diglossa barbitula* [*Diglossa barbitula barbitula*], all of which were described in the same paper, some place near the southern end of the Mexican tableland is clearly indicated. In the present connection, though, it is not necessary to designate a precise type locality.

Although several ornithologists have long been aware that there are two races of the Spotted Screech Owl, Mr. Ludlow Griscom[2] is the first, so far as I am aware, to indicate this in print. There has been for years material sufficient to demonstrate the fact that the Arizona and northwestern Mexico population was racially very distinct from that of Central America, but which of these races was representative of typical *trichopsis* has been entirely a matter of conjecture, since there are no specimens definitely known to be from southern Mexico extant in American collec-

[1] Isis, von Oken, [25] 1832, Heft 3 [March], col. 276. (Mexico). The long description indicates, though not conclusively so, the northern race.

[2] Bull. Amer. Mus. Nat. Hist., 64, 1932, 169.

tions. In the hope that Wagler's type specimen was still in existence I wrote to Dr. A. Laubmann, Curator of Birds for the Zoologische Sammlung des Bayerischen Staats in Munich, for any information he might have on the subject. Dr. Laubmann kindly replied at once that inquiries at the Würzburg Museum had failed to produce anything but the information that the type was missing and had probably been thrown out years ago. Finally I wrote to Dr. N. B. Kinnear at the British Museum, indicating the racial characters and sending him a specimen of each form. This latter gentleman's reply sets at rest any doubt that a single form ranges continuously throughout the Mexican highlands, for he says: "We have two specimens from Arizona which agree with your bird from that locality.... Six skins from Chimpala [Mexico], Ajusco [D. F.], Omilteme [Guerrero], and Oaxaca are the same as the Arizona birds." This determination, of course, makes *Scops asio*, var. *enano* Ridgway,[3] *Megascops asperus* Brewster[4] and *Megascops ridgwayi* Nelson and Palmer[5] synonyms of *trichopsis*. Determination of the relationships of *Megascops pinosus* Nelson and Palmer[6] must await the collection of adult specimens.

Since there is no available name for the race inhabiting the northern Central American highlands and which is completely isolated from the typical Mexican race by the Isthmus of Tehuantepec, it may be designated as

Otus trichopsis mesamericanus subs. nov.

Type.—Breeding adult male in the gray phase; no. 18,509, Dickey collection at the California Institute of Technology; Los Esesmiles, Chalatenango, El Salvador; March 2, 1927; altitude 8,000 feet in the oak-pine association of the Arid Upper Tropical Zone; collected by A. J. van Rossem; original number 11,372.

Subspecific characters.—Resembles *Otus trichopsis trichopsis* (Wagler) of Mexico and southern Arizona but dark markings everywhere narrower, more wavy and less contrasted with the ground color; white markings everywhere restricted and coloration very much redder when corresponding phases are compared.

Range.—Highlands (Arid Upper Tropical Zone) of Guatemala, El Salvador and probably Honduras.

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[3] Bull. Essex Inst., 5, Dec., 1873, 200 (Mexico). The type has been examined, thanks to the courtesy of the American Museum of Natural History, and I find it to be indistinguishable from the browner Arizona birds.

[4] Auk, 5, Jan., 1888, 87 (El Carmen, Chihuahua).

[5] Auk, 11, Jan., 1894, 40 (Patzcuaro, Michoacan). Juvenile in rufous phase (fide Ridgway).

[6] ibid., 40 (Las Vigas, Vera Cruz).

Remarks.—Typical *trichopsis* in the great majority of cases occurs as an almost pure ashy gray phase with the black and white markings in strong contrast. In addition there is a definitely brownish phase, comparable in color to the "gray" phase of *mesamericanus*, from which it is distinguishable by the broader, more prominent markings and more extensive white areas. There is probably a rufous phase also, as indicated by the juvenile type of "*Megascops ridgwayi*," but I have never seen an adult specimen so colored. *Mesamericanus*, similarly, has three phases, a grayish brown, a rufous and an intermediate which varyingly connects the two extremes. Although in *trichopsis* the gray phase is vastly predominant, the brown or intermediate uncommon and the rufous evidently extremely rare, *mesamericanus* appears to divide the three phases more equably. The term "gray" as applied to *mesamericanus* is, of course, a purely relative one used to denote the least reddish phase, since anything like the gray extreme of *trichopsis* is unknown in Central America.

The ranges of the two races of the Spotted Screech Owl are as follows:

Otus trichopsis trichopsis (Wagler)

Mountains of southeastern and southcentral Arizona (Chiricahua, Huachuca, Catalina, Santa Rita and Pajarito ranges) south through the highlands of Mexico to Oaxaca.

Otus trichopsis mesamericanus van Rossem

Mountains (Arid Upper Tropical Zone) of Guatemala, El Salvador and probably Honduras.

Besides the individuals and institutions to whom acknowledgments have been made in the text I wish to thank Dr. Loye Miller, of the University of California at Los Angeles, and the authorities of the United States National Museum for the loan of necessary material.

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TRANSACTIONS

OF THE

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VOLUME VII, No. 18, pp. 187-208, plates 10, 11

NOTES ON THE DESERT TORTOISE (TESTUDO AGASSIZII)

BY

LOYE MILLER

Professor of Biology, University of California at Los Angeles

SAN DIEGO, CALIFORNIA

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TRANSACTIONS

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NOTES ON THE DESERT TORTOISE (TESTUDO AGASSIZII)

BY

LOYE MILLER

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For a period extending over some twenty years, the present writer has been in search of new light upon the life history and habits of the Desert Tortoise, *Testudo agassizii* (Cooper). We are all becoming desert conscious these days, and characteristic forms of life from the desert have an appeal to the popular interest. The habitat is so positive, both in topography and in climate, and so many other species from the region have developed marked adaptations to the austere conditions under which they live, that this strange tortoise has been the object of scrutiny in an effort to learn whether or no it would display any unusual phase of specialization. The result of efforts thus far has been the accumulation of some worth while notes upon the eggs and growth rate, concerning which but little has heretofore been recorded.

Camp (1916, pp. 512-514) has given the most extended account in recent literature. In his account he speaks of finding in the tortoise burrows some broken egg shells presumably of the same species. In another note (1917, p. 85) he briefly describes a single egg sent to him from California, that was laid by a tortoise in captivity and buried, along with three others of the same clutch, in a shallow excavation. About twenty years ago Mr. Wm. Ray Shaw, then of Victorville, California, placed in my hands an unbroken egg which, by exclusion, we identified as the product of this reptile. When eggs were later obtained, a comparison proved the identification correct. The egg was found on the surface of the ground unprotected and, as would be expected, it failed to hatch.

Much journeying over the deserts of Arizona and California has yielded to my own efforts only a dozen or so specimens of the tortoise, but there has been no time during the last twenty-five years that I have not had several of them in my laboratory from the Colorado or the Mojave deserts of California. Only a few sets of eggs have been deposited during this time, although sexual activity has been repeatedly noted. In October of 1916 a full grown female deposited a full set of eggs, the first material of positive identity that had fallen into my hands thus far. Per-

haps "fallen into my hands" is an expression of unusual aptness in this case since one of the eggs was actually dropped from the female cloaca into my extended palm. Here at least specific identity seems positively assured.

In the case of my captives, no opportunity to dig burrows was available since the animals roamed about on the deck of a large balcony. There is every reason to believe with Camp (1916, p. 513) that, in nature, the eggs are laid in the protection of burrows after the fashion of some related species. Certainly some such protection would be necessary since exposure to the direct sunlight of the desert, even for a short time would prove fatal to eggs or to young tortoises. An adult specimen which became accidentally overturned upon the exposed deck, perished even in the relatively mild climate of Los Angeles.

The female from which the five eggs here discussed were obtained was picked up in Death Valley, California, late in the spring of 1916, its shell worn smooth by the sand blasts of the desert. The first egg appeared upon the deck roof on October 4 of the same year. The second egg appeared on the 7th, and another on the 8th at 1:30 p. m., followed by the fourth just thirty minutes later. The fifth and final egg was not laid until October 30. There seems then to be no regularity of interval between ovipositions nor were the eggs placed in any particular spot, no two being dropped in the same part of the ninety-foot deck over which the reptile ranged. In all probability the eggs deposited in a natural environment are also placed singly as the animal roams at random across the desert.

The peculiar posture assumed during oviposition was a notable feature of the process and it was practically the same on both occasions when it was observed. The anterior end of the plastron rested upon the deck while the posterior end was raised to the extreme limit of the hind legs. This position gave the egg at least two inches to drop—a distance which proved disastrous in one case, as the egg was cracked by dropping upon the hard surface. Why the animal should assume so grotesque an attitude seems an enigma. It could scarcely be due to a paroxysm of labor since in one case, the anterior limbs remained quite flaccid with no effort apparent. A considerable quantity of watery fluid was extruded with the egg so that a wet spot six inches in diameter was formed on the deck—a spot which dried without leaving appreciable stain.

The egg which was dropped into my hand felt quite warm so the temperature of the animal was at once taken through the cloaca. The

resulting temperature of 25 degrees C. was just five degrees above that of the surrounding air. The cloacal sphincter was found to be much relaxed and, upon stimulation with the thermometer tube, the cloaca dilated until the entire atrial chamber became visible through the orifice. Oviposition could easily be accomplished without appreciable effort.

CHARACTERS OF THE EGG

At the moment of deposition the egg is decidedly moist so that the shell appears quite translucent although perfectly hard. It is not like some lizard eggs (*Gecko*), soft at deposition and dependent upon exposure to the air for hardening. This translucence permits of an excellent view of the shell's contents, revealing a small gas bubble some three to four millimeters in diameter that changes position with the rotation of the shell almost as readily as does the bubble in a spirit level. The albumen layer appears to be extremely fluid. After several minutes, owing to the drying of the shell, the bubble becomes less easily visible, yet a careful scrutiny will reveal it almost equally active after five months time. The fact that the bubble shows no appreciable change in size, and that the fluidity of the albumen seems unabated after so great a lapse of time suggests that the marked resistance to drying offered by the shell and the immediately adjacent layers of albumen constitute a great factor of safety for the species in the parching atmosphere of the desert.

The shell itself is extremely thick and hard. An oölogist's drill would make no impression upon it until a small pit was scratched in the surface with a dental tool. Even after a hole was started, drilling was more difficult than with any avian egg that I have met. The texture of the shell appears very coarse and rough to the touch. There are irregular papillations similar to those sometimes seen on the aberrant eggs of domestic fowls. This character is more pronounced in some eggs than in others, and is entirely absent from the specimen presented by Mr. Shaw. Examination with the hand lens shows large pits irregularly disposed and rather far apart. There appears none of that smooth gloss that often gives the finished touch to avian eggs, nor is there a chalky layer comparable to that seen in the eggs of certain water birds. In fact, the whole effect is of an unfinished product from the oölogist's point of view. No pigment of any kind is evident.

One of the features most striking to the oölogist was a marked degree of asymmetry to be noted in all of the eggs. They were of almost equal curvature at the two ends and approached the globular in general

shape, thus resembling the eggs of owls. The asymmetry appeared, however, in the inequality of the two shorter diameters. The transverse section is almost as markedly an ellipse as is the longitudinal. This character was about the same in all the specimens studied.

MEASUREMENTS IN MILLIMETERS OF EGGS OF *Testudo agassizii*:

	No. 1	*No. 2*	*No. 3*	*No. 4*
Length	41.6	44.0	43.3	48.7
Maximum transverse diameter . .	36.7	38.0	36.7	39.6
Minimum transverse diameter . .	34.9	36.0	35.5	38.2

The first egg discovered was cracked, presumably by dropping upon the deck from the elevated cloaca of the female. This specimen was opened and the contents removed for study. In the entire mass there appear three degrees of fluidity. There is a highly fluid albumen in which the small gas bubble is enclosed, then there is a very thickly viscid albumen irregularly disposed about the yolk and attached to the shell by a short peduncle. This peduncle is common to all the eggs as may readily be demonstrated by rotating the egg and watching the bubble—there is a definite area around which the bubble always makes a detour. Finally, there is a very tough, pale cream colored yolk within the more viscid albumen.

Ranging with the large female upon the roof deck were several smaller individuals, one of which was plainly a male, but there had been no noticeable sexual activity in this case. If the large female were pregnant, the spermatozoa must have been received while in the desert, not less than four months earlier. Such was quite within the realm of possibility, so an attempt was made to excite development of the eggs. Studies at the Carnegie Desert Laboratory (MacDougal, 1908, p. 78) record 30 degrees C. as the soil temperature on the Tucson desert at a depth of four feet. The cloacal temperature of the female, as stated above, was but five degrees less than this. Thirty degrees was therefore decided upon for the experiment in incubation. Six weeks of constant exposure to a dry heat of this degree failed to show any change whatever.

While I have not actually observed the hatching of the young from the egg, I have twice found a single individual within eighteen to fifty-six inches of the nest containing broken egg shells. These small tortoises have shown the dried yolk sac still exposed at the umbilical area, and their shells were still covered with a peculiar "bloom" that seemed to consist of dried albumen. Their tiny nails were needle-sharp and unworn, so it is

felt that they could not have gone far from the nest since hatching. These two specimens, and two others of comparable size, were found about the middle of October in the desert northeast of Barstow. They must have hatched during the late summer at the earliest.

In both cases the nest site pits were very shallow and were located in fine loose sand deposited by the wind. The egg shells were exposed in part, and a few passes of the fingers through the sand brought additional fragments to light. The shell bits were not of such quantity as to suggest more than one egg, and much deeper digging yielded no additional fragments. The very strong suggestion is that eggs are laid but one in a "nest" and this nest is but a few inches deep. From this shallow burial the young one could scramble to the surface and would perhaps bring parts of its shell with it in its struggles.

Miss Eleanor Forsyth, a student in my classes, reported on egg laying observed by her at Needles, California, on June 17, 1923. "The tortoise scratched a hole about three inches deep, doing all the digging with the hind foot, a single egg was deposited and covered by using the hind legs." The temperature of the soil was immediately taken and found to be 96 degrees F. (35 degrees C.). Another egg laying was observed by the same student. The depth was four inches and only the hind foot was used. The nest was in dry sandy soil, and in shade.

THE YOUNG AT HATCHING

The young tortoises but recently emerged measure from 44-47 millimeters (1⅜-1⅝ inches) in length. The eggs measured 42-48 mm. in length, so there is but slight distortion of the carapace by confinement within the egg shell. That there is some distortion is indicated by a more or less crumpled appearance of the plastron which takes some months finally to smooth out.

The little animals are nearly as broad as long, and the dorsiventral diameter is relatively great. They are "chunky," meaty little chaps when first picked up. Both those that were picked up within five feet of the empty egg shells, voided a quantity of water. The water could have come from but one source, *i. e.*, the metabolic changes of the original egg mass. There had been no rain on the desert during the larger part of the year. There was no free moisture in the dry eolian sand drift, and the animals had never taken succulent food. The jaws were virgin fresh and unstained, and there had been no fresh growth of plants since the previous early spring. (It was now October 15.) While being examined the next day,

one voided a tiny black pellet of fecal matter, which, tossed out in water, yielded sand grains and a few vegetable fibers. They probably begin feeding in the immediate vicinity upon hatching and like the adults, take any dry vegetable matter available. It certainly appears that free water is not essential to the hatching for some time.

The color of the young varies greatly. The general ground color varies from dull mustard yellow to warm light brown. Darker areas of slaty brown appear on each scale of the carapace in pleasing and symmetrical pattern, but this pattern varies with the various scutes and with different individuals. The nuchal and the caudal plates are both incomplete at birth, both of them being deeply notched and crenulated on the free margin as though they were growing out by granulation. All other scutes including marginals are shaped approximately as in the adult.

Ossification of the carapace is but poorly indicated at hatching and the whole shell remains soft for the three years that I have been able to keep numbered individuals. Specimens picked up on the desert that were larger than my three year olds are still soft. Just when the ossification becomes sufficient for protective armor is not yet known.

The umbilical area is quite incomplete at hatching. The median line between scales is incomplete and the shrivelled stalk of the yolk sac protrudes to some extent, gathering up sand grains while it is soft and retaining them for a period after drying. This distortion of the pattern at the umbilicus persists for at least a year, but seems to correct itself after that time within the second year.

The unworn claws are needle-sharp and there is a sharp pointed prominence on the rostral scale that appears to correspond with the egg tooth of some other reptiles and of birds. This egg tooth is present for a year, but disappears by the second year.

Growth Rings

"Can the age of a tortoise be determined by counting the rings on the scales?" This question is perhaps more often heard than any other regarding these reptiles. Such definite results have been obtained by the study of salmon scales that I was quite optimistic in the matter when I noted that the hatchlings were without growth rings. Very careful study was made of the pattern of the third vertebral scute, particularly in all young specimens obtained. Subsequent study of the same individual after one, two, and three years served greatly to cool my enthusiasm for the method. At birth the whole central area of the scale is finely and uniformly papillated.

At the margin of the scale these papillae abruptly increase in size so that a ridge is produced by the single row of papillae running all around the scale. Outside this ridge the growth area of the scale is located and its subsequent enlargement is accomplished by accretions to the margin. In young animals collected on the desert which had doubled their original size, this central area of papillation was very distinct and its dimensions were those of the hatchling scute. Study of known two year olds and of larger animals of unknown age established the uncertainty of the rings of growth outside the original area. A growth ring might be very well defined on one margin and fade out or else split into two rings on the opposite side of the same scale. An animal might be six years old by count on one scale and but five years old as indicated by another scale, or on the opposite side of the same scale. In still older animals that had been exposed to sand blasts on the desert, the whole central area and an indefinite number of rings may have been entirely obliterated by wear. Theoretically there would be an acceleration of growth during the active season which would result in a thickened ring in the growth area of the scale, followed by a thinner ring formed during quiescence. The rainfall and the temperature cycles on the desert do not necessarily coincide. The tortoises are quite responsive to temperature changes and become quiescent in cold weather. In parts of the reptile's habitat there may be a double rainy season or none at all. The winter rainy season may be unfavorably cold for tortoises and the crop of annual plants might pass while the tortoises were inert. Under animal house conditions, the food supply is continuous and temperature is the dominant influence. This factor is quite regular in its major fluctuations and produces a periodic activity. Even here the growth rings of captive specimens are irregular and do not accurately reflect seasonal activity.

STUDIES OF THE ADULT

The adult Desert Tortoise wanders freely over the higher parts of the Southern California desert from the Colorado River westward to the Red Rock Cañon area (Ricardo P. O.) north of Mojave. A point four miles off the road from Mojave to Bishop, in the region of Red Rock Cañon, is the most westerly point from which I have actually taken specimens. A point twelve miles north of Amboy is my most northerly collecting station. I have not found it in the low saline desert of the Salton basin, but several were taken in the higher rocky country east and slightly north of Mecca. In Arizona I have taken it as far east as the

Sulfur Spring Valley northeast of Tombstone. In none of these areas is the reptile at all common.

Five days rambling by a party of six people on the hills north of Barstow in most favorable season and territory yielded only four or five animals. The season was April, and green food was abundant both in the broken hills and on the bajadas. Fresh tracks, feces and deserted winter burrows were more common than on any other field trip, yet the animals were not often encountered.

In the fall (October 23) the adults were found holed up for the winter in the Barstow area. A tunnel of oval cross-section is dug into a sandy hillside and the animal goes in to a depth of two or three feet. There seems to be no attempt at filling the tunnel mouth (Plate 10, fig. 1). There is nothing to indicate that an animal returns to a burrow it has once left. Although adults have been extracted from their three-foot tunnels in late October, an active one was found wandering across the road near Providence Mountains on November 26 after a light rain. March to October (or November) seems to represent the period of activity on the high desert. In the Los Angeles area the period for captive animals is much greater. Diurnal activity varies with the temperature of the air. The heat of the day on the desert finds them quiescent under some shrub, and the cool early morning produces a like effect.

Food and Water

While free water may not be essential, these tortoises will drink deeply when water is available. Hatchlings placed in a dish of water will drink 30-60 swallows before raising the head, then take another draught of equal length. The capacity for drinking is almost incredible. A medium sized specimen was placed in a basin after careful weighing. The increase in weight after drinking equaled 41% of the body weight. The experiment was repeated six weeks later, and the increase was 43%. After a shower on the roof deck, my captive animals drink readily from the scuppers, and doubtless the same occurs in the desert on the infrequent occasions when precipitation is sufficient to yield free surface water.

Food of captive tortoises is most varied. Fresh vegetables, apples, melons, bread, cheese, clover, dry leaves, paper—all seem acceptable. On the desert they crop the heads of a composite flower, *Encelia* (*Geraea*) *canescens,* and doubtless would take any other fresh vegetation. Their behavior in captivity suggests that they eat the dried plants during the hotter parts of the year. Such would be necessary if any extended feeding

season were to exist since the annual plants have there a most restricted life span. On the other hand, there is little doubt but that long periods without either food or water are a common experience with the species.

METHODS OF DEFENSE

The excellent armament of tortoises and their power of almost complete retraction into the shell have branded them as almost completely passive in defense. Armor is doubtless their chief reliance. A large German police dog was observed to mouth and paw a specimen for a long time without effect beyond shallow scratches upon its shell. The coyote would find equal difficulty though some injury might be inflicted. The really powerful jaws have never been seen to function in a defensive way. Fighting between rival individuals seems to be limited to ramming with the gular area of the plastron which is developed into an extended and upturned process in the adult male. The animals lurch at one another with this process and endeavor to overturn the rival. Battles of this sort have been watched repeatedly. The inverted foe is seldom left helpless, however, the victor not being wise enough to leave him alone. Possibly his sportsmanship induces him to help his rival up so that they can enjoy another bout. At any rate, psychology seems to play an important part, for one of the pair finally develops an inferiority complex and makes off at a really rapid pace completely unharmed except in spirit. That this fighting is not purely a mating activity was proved by one of the hatchlings—an absurd youngster with the yolk sac still clinging to his plastron. He would lunge at his companion or at an extended finger without the slightest provocation. This reaction was still observable eighteen months after his capture.

Courtship has been observed only in captive animals and the period seems to extend over most of the warmer parts of the year. The male approaches the female with his neck extended and the head bobbing rapidly up and down. The female may retract or may go quietly on feeding or dozing in the sun. The male circles about, nipping clumsily at the edges of the female's shell, a most absurd caricature of the traditional "billing and cooing." Should the female remain retracted, the male may make a lunge at her with his gular "horn," but not with the pugnacity used against a rival.

Mating activity has been observed again and again, but no actual intromission could be detected, and eggs deposited on the roof deck have never shown fertility. It is my personal impression that the animals must be

upon fairly loose sand in order to assume the position that would allow complete coition.

Growth Rate

The growth rate of these reptiles is in most cases very slow. After a first-hand experience with one of the large Galapagos tortoises which grew from 29 lbs. to 395 lbs. in seven years, I was quite skeptical of the popular reports on the slow rate of growth in chelonians. I am now quite ready to credit the most extravagant of such reports. Observations were made on hatchlings and upon young that were surmised to be about five years old, and in but two cases was growth more than eleven percent per year.

Increase in Carapace Length in Young Tortoises

Number	*At Capture*	*1st yr.*	*2nd yr.*	*3rd yr.*	*Total*	*Percentage per yr.*
6	44.7 mm.	46.8 mm.	56.3 mm.	72.3 mm.	28.5 mm.	19%
7	43.7	46.6	51.8	.....	8.1	9%
11	46.9	70.4	.....	.....	23.5	50%
12	46.8	48.2	.....	.....	1.4	3%
8	85.2	93.3	98.5	.....	13.3	7.5%
9	68.2	75.2	81.3	.....	13.1	9.6%
1	123.0	.....	.....	130.0	17.0	4.1%
3	50.4	55.3	56.6	.....	6.2	6.2%
4	37.9	42.0	.....	.....	4.1	10.8%
A	106.0	.....	110.5	.....	4.5	2.1%

The two hatchlings mentioned above, Nos. 11 and 12, were picked up on the same day, and were the same size, both were in the immediate vicinity of their egg shells, they were kept under the same conditions in the same cage, yet No. 11 gained 50% and made three or four growth rings on his scutes while the other grew 3% and made no observable rings. Only one other among the ten young observed made a growth above 11%. This was No. 6 which was kept for three years and averaged 19%, but at the end of that time the shell was still soft. Its length was then 72.3 mm. No. 9, picked up in the wild, measured 68.2 mm. It was still soft in the center of the plastron after two years and after reaching a length of 81.3 mm. No. 8 was picked up in the wild at 85.2 mm. length, and had a firm shell. I am of the opinion that the shell remains soft until the carapace is about 80 mm. in length, and that this length is not attained under four or five years from hatching. My laboratory animals

are kept under conditions of food and water more favorable than their native habitat. The temperature extremes are less, but since the temperature at the laboratory is sufficient in summer to prove fatal to an exposed and helpless tortoise, I assume that the growing period at Los Angeles is probably longer than it is on the desert. All factors considered, these observations on growth probably represent a somewhat greater than normal growth rate.

Regeneration and healing of wounds has been observed under laboratory conditions as well as in the wild. One individual of 123 mm. length was brought in from the field with the gular beak of the plastron injured, the corneous scales had been torn off, and the exposed bone was seemingly dead. After three years in captivity the dead area of bone had sloughed off and corneous material had covered the scar. The slough line was not coincident with any suture line, but was more or less oblique. The carapace length had increased but 7 mm. in the three years. Four individuals taken in the wild had suffered severe wounds in the carapace which had been completely repaired resulting in one case in quite noticeable lameness. These wounds were probably produced by falling rocks or by the reptiles themselves rolling down rocky hillsides. The creatures have an insatiable urge to travel, and they work their way up loose rock slides where they have been observed to start a miniature land slide that carried them bumping and tumbling to the bottom of a cañon. In such cases they are again passive in defense, merely retracting into the shell and letting gravity have its way.

DISEASES

Three types of lesion have been noted in the Desert Tortoise. In captivity there have appeared several cases of inflammation of the skin about the head which seems to affect also the membranes of the eye, resulting in entire closure of one or both of the eyes. Treatment of the parts with various antiseptics was not successful and the animals were finally chloroformed. These cases were separated far in point of time and other specimens in the same enclosure did not become infected. Another dermal lesion which may have been causally the same, affected the carapace, resulting in supuration along the growth zones between scutes and eventual sloughing of the scutes. It is not known whether this infection would prove fatal or not, but the possibility of infecting other animals made it seem wise to dispose of such patients. These cases are mentioned as possible control factors in wild animals. One specimen of

about 85 mm. length was captured in the desert and appeared to have had some disease of the dorsal scutes which had been corrected, leaving the corneous material less translucent and somewhat crackled in appearance.

Another lesion found in four cases is concretion within the urinary bladder. This condition has been seen in animals from the Barstow area only, where it was first noted in a dried carcass found on the surface of the desert. The specimen was of large size and, when picked up, was seen to contain a spherical concretion so large that it could not be removed without breaking either it or the shell. Two adult tortoises that have died in captivity from no visible cause have been found to contain similar concretions in the bladder, and the stones were discovered only after boiling up the animal for cleaning the skeleton. The specimen found dead on the desert doubtless died from the same cause. No animal actually dissected has contained such concretion, but the allocation of the stone to the urinary cyst is supported by both its shape and its composition.

The shape is roughly globular with a maximum diameter of 60 mm. and a minimum of 50 mm. When broken it shows a concentric structure of chalky material having the color and odor of the renal discharge of normal reptiles. There is enough organic matter contained in it to cause dermestid beetles to atttack and bore into it. In all probability bladder stone constitutes one factor in the mortality rate of adult tortoises.

Enemies

The tortoise after its shell has become hardened probably has pretty effective defense against animal foes except man. I have no evidence that Indians used it for food, but there appears no reason other than religious or ceremonial tabu that would restrain them. These religious restrictions vary much from tribe to tribe and there has been much shifting of Indian population within recent centuries, hence man has probably had something of an influence upon the abundance of the species down to historic times. Since the advent of the white man, whether with pack burro or motor car, the tortoises have fared badly. I have found their bones about prospectors' camps, and have heard many accounts of the relief that tortoise, chuckawalla or even rattlesnake offer from the desert men's menu of beans and salt meat.

At present there are many specimens picked up by the curious motorist, thrown into the back of the car, and carried home to the city dwellers' backyards whence they soon escape and wander out into traffic

to perish. One enterprising Italian is reported to supply his Los Angeles restaurant with the essentials of genuine terrapin soup. There is little danger of such becoming an extended enterprise, however, because of the scarcity of the animals, even on the most favorable deserts.

The great danger to the species doubtless lies in the long period of infancy during which the shell is soft. The assumption is made above that five years probably passes before the shell ossifies enough for effective defense against predatory mammals. The coyote or badger would make short work of such a youngster. An American Raven, collected at Barstow, had the skull and feet of a young tortoise in the stomach. A dried shell, 70 mm. long, collected near Barstow had three of the costal plates of the carapace and most of the marginals torn out, and the contents eaten by some predator, apparently a raven. Even with the best of color protection, many young tortoises must fall victim to the beaks of these keen eyed hunters.

No evidence thus far gleaned would suggest more than five eggs per season for an individual female. With such low birth rate and high rate of infant mortality, there must be an enormous longevity of the mature animal in order that the species survive.

ADAPTATIONS

There are several characters which are favorable to the survival of this species in its conflict with the austere environment of its desert habitat. Primarily, perhaps, is the low evaporation coefficient of the egg. Five months after deposition the fluidity of the albumen and the size of the "air bubble" in the egg under observation appears unchanged. The resistance to dessication seems to be carried over to the hatchling and to continue perhaps increasingly throughout life. Secondly, the probable ability of the animal to utilize and conserve "metabolized" water produced as an end product from food within the egg mass before hatching and from the food after hatching, is notable. The carbohydrate molecule has a general formula of $Cx(H_2O)y$ where x may sometimes equal y. Respiration would have as its end product x parts of CO_2 gas which requires no water for its elimination, and y parts of water usable as a solvent. Even the products of protein oxidation differ from those of typical mammals. Urea is produced by mammals, while uric acid or its ammonium salt is the corresponding product of birds and reptiles. Urea is soluble and highly toxic, hence must be eliminated at the expense of much solvent water before its concentration becomes too great. Uric acid, on the other

hand, is almost insoluble, hence less toxic, and is voided as a whitish solid by the reptile, and a minimum of water is lost. Hence the exclusively vegetable diet with high carbohydrate content is markedly in the animal's favor in the conservation of water.

Again there is an enormous ability to withstand periods of adverse climatic conditions. Either hibernation or aestivation may be resorted to, and the desert being a place of extremes rapidly shifted, the change from one to the other type of adjustment may be rapid. The probably long life span certainly must be of value in the conflict. The rate of development is so slow, and the rate of living is so slow that they must necessarily live a long time to get much living done, so to speak. The birth rate is so low and infant mortality so high that longevity again becomes a necessity. The insatiable urge to travel and the enormous persistence that drives it to repeated attempts and to ultimate triumph (where possible) in overcoming obstacles in its path, carry it over great distances and varied topography.

Where food is sparsely distributed this wanderlust probably serves as a distinct advantage. Power to survive and to repair physical injuries is so marked in many reptiles that the Desert Tortoise cannot be considered specialized in this respect, yet the ability must be often severely taxed in the desert.

Considered altogether, the species constitutes a most fascinating element in the biota of our southwestern deserts, and my own feeling is that it merits our greatest consideration in order that it may continue upon its harmless way.

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EXPLANATION OF PLATES

PLATE 10

Fig. 1. Winter burrow of *Testudo agassizii* on the Mojave Desert near Barstow, California. (Photograph by Carl Chambers)

Fig. 2. Nest cavity of *Testudo agassizii*. Broken shells visible in right center. Mojave Desert near Barstow, California. (Photograph by Carl Chambers)

Fig. 1

Fig. 2

PLATE 11

Fig. 1. Young of *Testudo agassizii*. No. 6 is three years old, No. 11 is one year old. They have about the same number of growth rings on the scales. Actual length of the carapace, 72.3 and 70. mm. (Photograph by Loye Miller)

Fig. 2. Young of *Testudo agassizii*. No. 3. This animal is two years old and shows growth ridges on the left side of the vertebral scute No. 3, and three ridges on the right side. Length of carapace, 56.6 mm. (Photograph by Joseph Dixon)

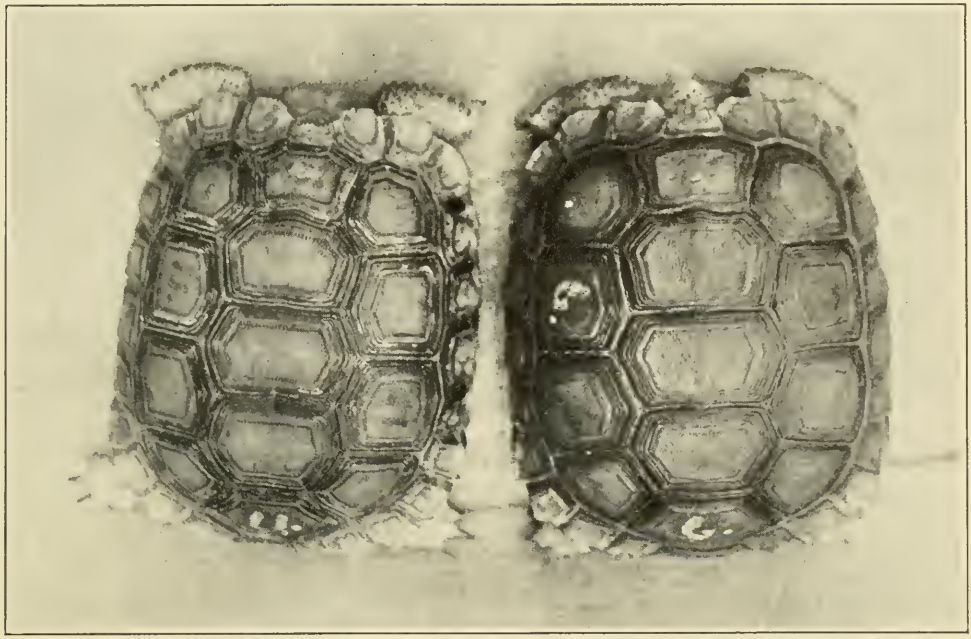

Fig. 1

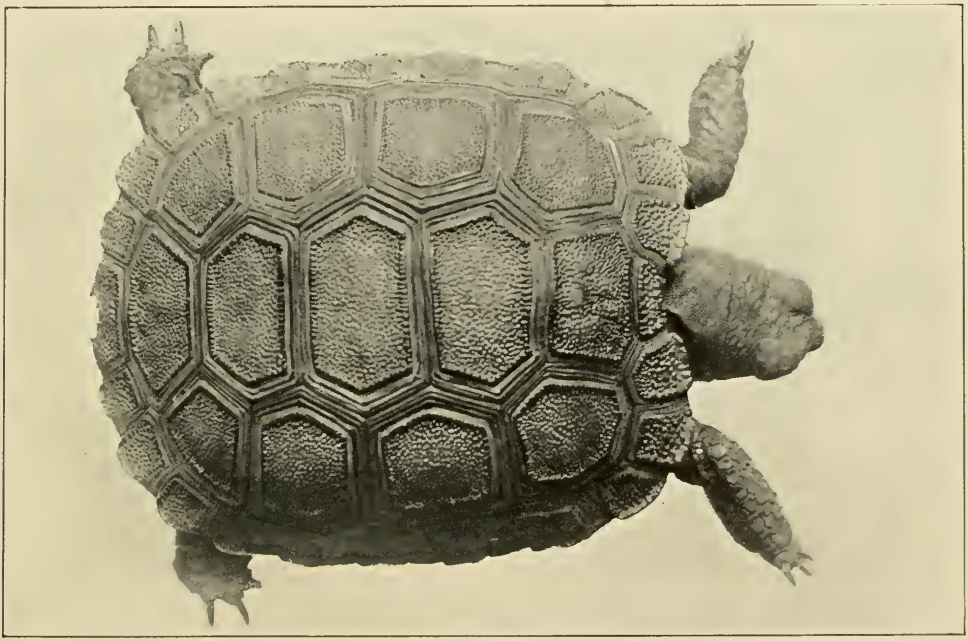

Fig. 2

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VOL. VII, NO. 19, pp. 209-210 MARCH 31, 1933

A PLEISTOCENE RECORD OF THE FLAMMEOLATED SCREECH OWL

BY

LOYE MILLER

University of California at Los Angeles

In the year 1911, the Pleistocene bird remains from three California caverns were studied by myself during a general survey of the fossil bird fauna of the Pacific Coast, the results being recorded in one of a series of papers[1] on the subject. During this effort a single, almost perfect tarsus from Samwel cave was assigned to the species *Micropallas whitneyi* (Cooper). This conclusion was reached on the basis of size and proportions in comparison with other available Recent owls and Shufeldt's study of the ligamentous skeleton of *Micropallas*. (Again I would inveigh against the ligamentous skeleton for the study of single bones.)

Now, after twenty years, there have become available a number of completely cleaned skeletons of the Elf Owl, and my sincere thanks are extended Mr. A. J. van Rossem in charge of the D. R. Dickey collection for permission to dissect out the tarsus of a cabinet specimen of the Flammeolated Screech Owl (*Otus flammeolus*). Much to my surprise I find that this rare little owl, when deprived of its feathers, is reduced almost to elfin size, in fact, between the tarsi, the size difference is so slight that it falls within the range of variation commonly seen between the sexes of such birds. Through the courtesy of Dr. J. Grinnell, the body skeleton of *O. flammeolus* was made available, and from this material it is seen that the size character is more notable in the leg bones than in the wing and the body bones.

[1] Univ. Calif. Publ., Bull. Dept. Geol., vol. 6, no. 16, pp. 385-400. 1911.

Comparing the tarsus of *O. flammeolus,* ♀, with the fossil from Samwel cave, the fossil is distinguishable only by a slight slenderness of shaft and more open foramina, both of which suggest a more youthful individual. I feel no hesitation in assigning the two bones to the same species.

The great surprise came in finding the Flammeolated Owl so close in its general proportions to the Elf Owl. The tarsal length is very slightly greater, and the shaft diameter about equal, thus making the relative stoutness of *flammeolus* appreciably less. The fundamental differences lie in parts concealed in a ligamental skeleton. The head of the tarsus in *O. flammeolus* is more distorted owing to the much larger size of the inner cotyla. In *M. whitneyi* the two cotylae are almost equal. The distal trochleae of *O. flammeolus* are larger and describe more of an arc than appears in *M. whitneyi.*

Our smallest western race of *Otus asio,* i. e., *gilmani,* appears almost gigantic in comparison with *flammeolus,* and the little tropical *Otus trichopsis* is likewise plainly in the larger size group. In general size and especially in weakness of the leg, *Otus flammeolus* seems to stand quite apart from the typical screech owls of the United States. Its extreme rareness at the present time makes its discovery as a fossil especially interesting and strongly tempts one to draw certain inferences regarding its status in the geologic sequence. When a species is found preserved as a fossil we consider it to have been represented by a goodly number of living individuals at the time of entombment. The chances of long preservation are so few compared with the enormous numbers destroyed that this assumption seems reasonable. A question arises, then, regarding the cause of decline in numbers to the present status of rarity. Human agency seems not to have been a factor. The little owls occupy a terrain that is little disturbed by man's projects. The larger owls (*Bubo*) that have a strong cannibalistic leaning, were present in Pleistocene of the same locality (*B. sinclairi*). Food supply seems improbable as a factor.

Racial senility, the final recourse (or subterfuge?) of the paleontologist, would have to be invoked, and we may look upon *Otus flammeolus* as a species on its way to oblivion.

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VOLUME VII, No. 20, pp. 211-258, plates 12-15, text figs. 1-34

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GRANITIC DOMES OF THE MOHAVE DESERT, CALIFORNIA

BY

WILLIAM MORRIS DAVIS

Balch Graduate School of the Geological Sciences
California Institute of Technology
Pasadena, California

PUBLISHED WITH AID OF A GRANT FROM THE FUNDS
FOR PUBLICATION OF RESEARCH
OF THE NATIONAL ACADEMY OF SCIENCES

SAN DIEGO, CALIFORNIA
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The Cima Dome, looking south. (Photo by Blackwelder)

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Summary

Several granitic areas in the Mohave Desert region of southeastern California have been degraded to smooth dome-like forms, to which Lawson has given the name, panfans. They have diameters of from 3 to 6 or 8 miles and heights of from 500 to 2,000 feet over the adjacent lower land. One of the best examples is shown in Plate 12. The well graded convexity of these masses, the steepest declivity of which seldom measures more than 4° or 5°, is flanked by the long, aggraded, concave slopes of their detritus. In some instances the domes are elongated into arches, 10 or 15 miles in length. Many other areas, granitic and non-granitic, less completely and less symmetrically degraded, exhibit bold or subdued residual forms surmounting their smoothly degraded flanks.

The most perfect domes or arches result from the undisturbed degradation of upheaved granitic masses which have been worked upon, according to their original form,[1] chiefly by one or the other of two somewhat unlike erosional processes, both of which are merely modifications of ordinary erosional processes appropriate to the dry climate where their action takes place.

One process involves mainly the back-wearing of the steep scarps of an upfaulted granitic lowland, previously degraded to low relief, the detritus shed from the retreating scarps being swept away by sheetfloods. Down-wearing of the upfaulted mass by streams is in this case relatively unimportant. The back-wearing takes place in a manner first analysed by Lawson (1915), but his analysis is here somewhat modified. Under this process the mountain faces are, as they retreat, completely—one might almost say, once for all—reduced to gentle slopes of sheetflood smoothness. The process is largely dependent on the habit of granitic rocks to weather both by surface exfoliation and by interior disintegration, so that when a large and angular joint-block is gradually reduced by exfoliation to a roundish core about a foot in diameter, it breaks down into fine granular detritus. Rocks other than granite, being less uniform in structure and weathering into angular blocks, scraps and grains, assume mountainous or hilly forms, unlike granitic domes.

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1 The phrase, original form, is here used in a somewhat special sense in contrast to initial form. The initial form of a land mass is the form that it had when deformation interrupted the cycle of erosion previously current and introduced a new cycle. The original or potential form is the form that it would have when the deformation is completed, provided no erosion took place during the deformation.

The second process of dome production, which involves mainly the down-wearing of broadly upwarped granitic masses of low relief by the excavation of ordinary valleys along innumerable, divaricating drainage lines, will be discussed in another essay, to be published in the Bulletin of the Geological Society of America under the title, Sheetfloods and Streamfloods.

Domes are best developed in areas of granitic rocks for two other reasons than their manner of weathering as specified above. No other resistant, mountain-making rocks commonly have a uniform structure over an area large enough for the production of good-sized domes; and no other mountain-making rocks waste away so rapidly as granites under arid weathering. Hence as a rule only these rocks have found the quiescent periods, which have been granted during the later geological ages to one or another part of the earth's crust in elsewhere uneasy Southern California, long enough for their reduction to completely graded, broadly convex forms. If these conclusions are correct, the original forms and altitudes of the upheaved granitic masses now represented by graded domes or arches may be in some cases roughly inferred from certain details of the present forms; that is, certain domes or arches may be regarded, even after all the residuals of the original form have vanished, as representing far-advanced stages in the arid degradation of fault-block Basin Ranges.

INTRODUCTION

The districts of southeastern California, in which the uncompleted and the completed granite[2] domes described in this essay occur, are located on the outline map, Fig. 6. They are all included in the vaguely limited arid region known as the Mohave Desert, of which an excellent description has been given by Thompson (1929). As shown by the many dotted lines, I have traversed various parts of the region at intervals in the past 6 years in company with Dr. L. F. Noble of the U. S. Geological Survey; Mr. Samuel Storrow, one of my students in the Harvard Class of 1887, now a retired engineer in Los Angeles; Mr. Myron Hunt, architect in Pasadena and lover of all out-doors; and several of my recent students in the California Institute of Technology at Pasadena. To all of these companionable associates I am much indebted for transportation and photographs, as well as for generous encouragement and assistance in my

[2] The old petrographic term, granite, is here used in a general physiographic sense, like that adopted for the old physiographic term, valley, by petrographers.

observations. To Professor Eliot Blackwelder of Stanford University I am gratefully indebted for his fine photograph of the Cima Dome.

The discussion which follows is limited chiefly to areas of granitic rocks because they, for reasons above stated, afford the best examples of smoothly convex domes and arches. Mountains of other kinds of rocks will be briefly treated in special sections.

PART I. THE THEORY OF DOME DEVELOPMENT

The Form of Graded Divides. Lawson's keenly analytical essay on the "Epigene Profiles of the Desert" has been an indispensable introduction to what here follows. He there discussed the processes of arid degradation with special reference to their action on upwarped or upfaulted masses "lithologically and structurally homogeneous" (1915, 25:3),[3] having highland surfaces of so low relief, in consequence of degradation in an earlier cycle of erosion, that their down-wearing degradation is slow except along occasional drainage lines, and having marginal slopes or scarps so bold that their back-wearing degradation is relatively rapid. He thus showed that where the original slope[4] of an upheaved rock mass is steeper than the slope of repose of its weathered detritus, "hard rocks present persistently steep slopes throughout the entire period of their degradation. The epigene rock slopes appear to be just as steep in old residual mountains, almost buried in alluvium, as in youthful mountains with but a small embankment of detritus at their base" (27:3). Hence, after the original slopes are weathered back to steep faces (or "subaerial fronts") of proper declivity, commonly about 35° for granitic rocks, they will retreat at a uniform rate parallel to themselves, somewhat as in Fig. 1, until each side of the upheaved mass is completely reduced to a systematically inclined rock floor (or "suballuvial bench") of hyperbolic profile, over-spread with a detrital cover (or "subaerial embankment"), which

[3] In certain citations a digit following a colon after a page number represents the position of the cited statement on its page in ninths of the page height, counting down from the page top.

[4] See foot note p. 214. It may be noted that Lawson's analysis assumes the upfaulting of a mountain mass to be completed before its recessional degradation begins. Intermittent upfaulting would produce, for a time, a benched scarp; but as no such forms have been found they must, if ever occurring, have been destroyed by further retrogression. The extreme case of upfaulting so slow that it has been overcome by contemporaneous degradation need not be considered because all the mountain ranges of the region show that degradation has been far exceeded by upheaval.

thickens at a diminishing rate and which usually slants forward with gently concave profile to an aggrading playa.[5]

Lawson's analysis also showed that the detrital cover should ordinarily become thinner and thinner up-slope, so that it must be reduced to a feather-edge when the area of the rock floor on which it rests is sufficiently increased. This is because the essentially constant acclivity of the overlapping cover must be more and more nearly paralleled by the decreasing up-slope curvature of the underlying rock floor, just as a rectilinear asymptote is more and more nearly approached and paralleled by its arm

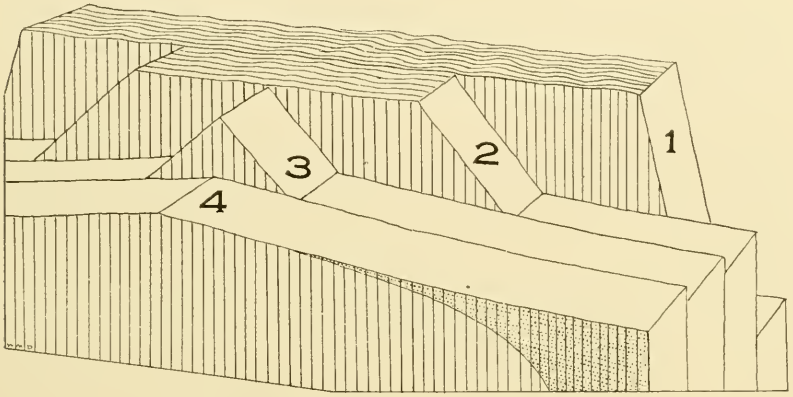

Fig. 1. Development of a blunt-angled rock floor.

of a hyperbola. It is therefore concluded that, if the retrogressive wasting of a mountain face be prolonged beyond the feather-edge of its detrital cover, as it may be in a late stage of the degradation of a large granitic mass, a "bare rock surface" will be developed; and that this surface will be extended "without appreciable change of slope" (38:2) until it extinguishes the surmounting rock residuals by meeting a similar rock surface ascending from the other side of the upheaved mass. There the intersection of the two surfaces will define a blunt-angled crest line, Block 4, Fig. 1, and the degraded mass will constitute, not a broadly convex arch

[5] Readers are warned not to regard this brief statement as representing in any adequate way Lawson's closely argued discussion of the problem of arid degradation, in which he begins with ideally simplified conditions and successively introduces a large variety of complications by which actual conditions are approached. Close study is needed to appreciate his thorough deductive analysis, which deserves to be ranked as a worthy supplement, for arid regions, to Gilbert's famous essay on Land Sculpture in his Report on the Henry Mountains; for that essay, although prepared after experience chiefly in an arid country, was mostly concerned with the degradational processes of humid regions.

or dome, but a "low rock ridge of symmetrical slopes" (31:7), and of essentially uniform declivity in its upper part.

In case the originally upheaved mass is of ovoid outline, so that, instead of a bilateral, a peripheral rock floor is developed around it, it would, under the above explanation, eventually assume the form of a blunt-angled cone. Johnson, following Lawson for the most part, brings out this result explicitly: "In the case of an originally circular mountain mass the end-result would be a far-spreading low rock cone blanketed in considerable part by overlapping alluvial deposits:" also, the general degradation of the central area would produce "a low conical rock pediment, relatively free from alluvium, the ultimate type form of the arid landscape" (1932, 390).

Each down-slope element of either a blunt-angled ridge or cone would be regarded by its sheetflood as having a slope for transportation only, down which the detritus from the retreating mountain face would be swept without erosional action. The sheetflood would therefore resemble a graded river in the sense that, however much detritus is washed along its slanting course, no erosion is there accomplished: for it is only under that condition of non-erosional transportation that the graded rock floor should have a hyperbolic profile. It is here that my explanation of the problem begins to differ from that of my predecessors.

The Development of Concave Profiles. The statement of our differences of view may be introduced by examining Lawson's special case of an upfaulted mass, the original upper surface of which, instead of being nearly level, increases in height toward its mid-line, as in Fig. 2, so that its

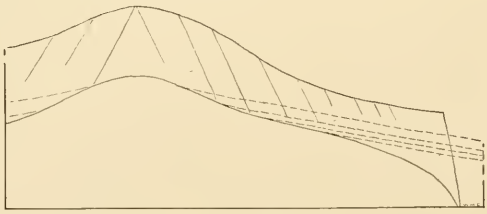

Fig. 2. Development of a concave rock floor.

mountain face grows higher and higher as it retreats, and it therefore sheds a greater and greater load of detritus to its base, to be swept away by the piedmont sheetfloods. Under such conditions the rock floor to which the upfaulted mass is retrogressively reduced must develop for a time, as Lawson shows, a concave profile of increasing steepness as its area in-

creases.[6] This conclusion seems correct, although no actual examples of the kind have been recognized, perhaps because the growing edge of their rock floors would be covered right up to the base of the mountain face with a detrital cover of by no means feather-edge thinness.

The Development of Convex Profiles.[7] The case of an upheaved mass that does not increase in height toward its mid-line has not been so fully analysed. Lawson's brief statement is that the graded profile of such a mass will be, as compared to that of an originally convex mass, "flatter without changing the character of its [hyperbolic] curvature" (36:6); that is, without diminishing the tendency of the upper part of the profile to become rectilinear. This conclusion seems to me to be erroneous. To make my point clear let it be recalled that the essential condition for the development of a hyperbolic profile is that, while the mountain face retreats parallel to itself at a uniform rate (35:7), the detrital cover rises parallel to itself at a diminishing rate, chiefly because of the decreasing height of the face from which detritus is shed (35:5). This implies that all the detritus supplied to the cover comes from the steep mountain face, and hence that none comes from the degraded and gently sloping rock floor beneath the face. The grounds for an opposite inference are as follows.

Fig. 3 Development of a convex rock floor.

If an upheaved mass has an originally nearly level surface, Fig. 3—and such is the form assumed in Lawson's Fig. 3, which illustrates the development of hyperbolic profiles—its retreating face must become shorter and shorter and the load of detritus delivered from it must become smaller and smaller as time goes on. A time must therefore come when the delivered detritus will not provide a sufficient load for the piedmont

6 This result would apparently be favored if the drainage of a mountain face led to a near-by playa of small area, which would therefore be rapidly aggraded.

7 The inferences stated in this section first took conscious form in my mind during the night of April 30, 1932, which was spent where the Cave Spring road passes near the base of a large rock knob on the dissected part of the rock-floor piedmont to the Granite Mountains, described on a later page.

sheetfloods and thereafter they will no longer act simply as transporting agencies. They must then begin to rob the cover of some of its detritus or the rock floor of some of its disintegrated grains, with which to satisfy their excess of energy; and thence-forward the conditions for the development of an increasingly rectilinear profile can no longer obtain.

Rock-floor Robbing by Sheetfloods. As soon as such rock-floor robbing sets in, the up-slope extension of the already thin detrital cover will cease, and the rock floor thereafter developed will be of less and less acclivity as it is retrogressively extended farther and farther toward its eventual summit. For after the robbing of the floor has once begun, it must go on at an increasing rate so long as the detritus delivered from the retreating mountain face continues to decrease; and in consequence of such increase of floor robbing the floor must acquire a convex profile instead of maintaining an essentially uniform acclivity to its head. This conclusion seems to me quite as correct as the one announced in the third-preceding paragraph; and it has the additional merit of being repeatedly exemplified in nature, as will be shown below.

The manner in which rock-floor robbing operates appears to be as follows: A cloudburst flood, rushing down a steep but short mountain face and spreading in a sheet on the graded slope of the piedmont rock floor and its detrital cover, may there find its total load of detritus insufficient to satisfy its capacity. It will thereupon at once increase its load by taking up some detritus from the rock floor. But the amount that it takes up will be less than its deficiency of load, because, by the very act of taking up some detritus, the gradient of the floor will be diminished, the flow of the sheetflood will be retarded and its capacity will be lessened. Hence the amount of detritus taken up must be such that, when added to the load previously acquired, it will make a total no greater than can be carried by the lessened carrying power. And all these changes must go on by infinitesimals, as if the sheetfloods were familiar with the differential calculus. This case is the opposite of that of a loaded river to which more load is added. Such a river will not lay down all the new load, but only so much of it as will, by increasing the stream gradient, increase also its velocity and its carrying power, so that it can then carry all its former load and the non-deposited part of the new load.

Let it be understood, however, that the surface here called a rock floor, as well as that called a "bare rock surface" by Lawson (1915, 38:2), does not show firm, bare rock, but only disintegrated rock in place, grad-

ually passing into firm rock several feet underground. This is because, while the disintegration of a granitic mountain face causes its slow retreat, the disintegration of the floor at the mountain base slowly progresses downward; but while the steep mountain face is stripped of most of its finer waste, the floor is not. It appears to be with reference to the action of sheetfloods on this sheathing of disintegrated detritus that Lawson remarks: "Corrasion by running water is quite a subordinate part of the process by which desert mountains are degraded" (28:4); for corrasion is the process by which firm rock is worn away by water-borne detritus. It may be added that the surface of the disintegrated rock usually presents a much larger proportion of grains (or of angular scraps in non-granitic masses) than is found just below the surface, where fine sand and silt are plentiful; thus suggesting that they have been removed from the surface by the wind. A truly bare rock surface is found in rock domes only after active erosion, instigated by some change of conditions, removes the disintegrated rock.

It may be stated as a corollary to the above principle of rock-floor robbing that, even when the retreating remnant of a large and lofty mass of whatever form is eventually narrowed to a high, sharp-crested ridge, the detritus delivered from it will still satisfy the carrying power of the sheetfloods until the ridge is reduced to small height; only thereafter must the profile of the graded floor become convex. Inasmuch as the beginning of rock-floor convexity is here delayed until the originally large mass is reduced to a narrow ridge, the convexity will characterize only a small part of the completed profile. Such a mass will be, if elongated, a round-crested ridge instead of a broad arch; if ovoid, it will be a round-topped cone instead of a broad dome.

On the other hand, in the case of a broad and low mass, the retreating face will, at an early stage of its retreat, fail to shed detritus in sufficient quantity to satisfy its sheetfloods, and the convexity of the completed rock floor resulting from the back-wearing of such a mass will be early initiated. When such a mass is completely graded it will be, if elongated, a broadly convex arch; or if ovoid, a broadly convex dome. This, taken in reverse order, illustrates one of the ways in which rough inferences may be made as to the original form and altitude of an uplifted mass after all traces of the original form have vanished.

All these graded forms will be slowly reduced to less and less convexity as long as their region remains undisturbed. The manner in which such reduction takes place deserves brief consideration.

Degradation of Desert Domes. The most peculiar feature of dome degradation in an arid region which drains to aggrading playas is that the dome surface is most lowered at the top where it is flattest. It is less lowered on the flanks where it is steepest, and it is slightly built up on the basal slopes; but in a late stage of an arid cycle, when wind exportation of dust from the playas may gain the upper hand, the basal slopes also will be degraded. The agency by which the top of a dome is lowered fastest is chiefly sheetflood robbing of disintegrated rock, as above explained; and the manner in which the work goes forward seems to be very similar to that of rillsheet robbing on the round-topped hills of humid climates, as analysed by Lawson in a recent paper (1932) to which the reader will do well to refer. The leading contrast between the two cases seems to be that the slow degradation of the entire area, but still fastest at the convex crests, which may be theoretically expected in a late stage of an arid cycle, as above intimated, is continuously operative in a humid climate, because degradation there goes on with respect to slowly lowering stream courses; unless there also a temporary reversal of such lowering may take place near the streams in that stage of maturity when they spontaneously aggrade their courses slightly because their load increases after their slopes had become graded; but as old age is approached, such aggradation is followed by very slow and long continued degradation.

Terminology.[8] In spite of the risk of incurring censure, I propose, as may have been inferred from certain passages in the foregoing paragraphs, to replace the terminology hitherto in use for the kind of desert mountains here under discussion by a new one which seems to me in several respects more appropriate. Instead of using Lawson's term, "subaerial front" for the steep retreating slope of an upheaved mass, the ordinary term, mountain face or rock face, seems to be a sufficient designation. It may be noted that in granitic mountains, the face is craggy or bouldery; craggy where round-weathered ledges protrude; bouldery where detached blocks linger; finer detritus lies on it in protected nooks; also that a two-sided mountain mass retreating from its original fault scarps will, after first acquiring more or less indented and embayed margins and later narrowing to an irregular ridge with a serrate crest, be worn through in graded passes and

8 The law of priority may well be followed in cases of mere nomenclature; but descriptive terms often need change when the theoretical explanation which they connote is modified; and even for non-explanatory description terms later proposed are sometimes better than earlier ones. Let the fittest survive under the law of competition.

thus eventually be subdivided into isolated mounts, knobs and nubbins, as in Fig. 4.

The worn-down and graded rock floor which takes the place of the retreating mountain face is called by Lawson the "suballuvial bench," although it is by no means always either bench-like or suballuvial. Bryan, Blackwelder, King and others call it by McGee's descriptive term, pedi-

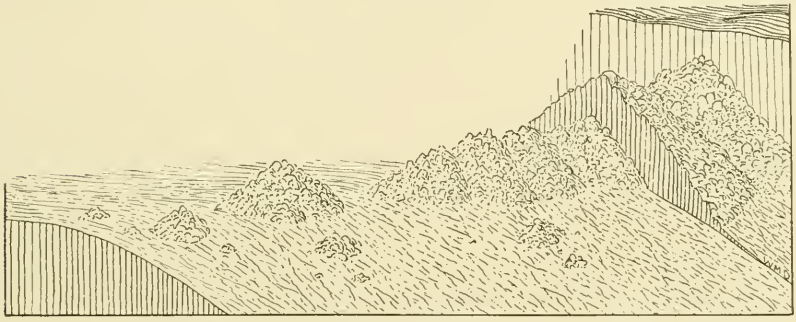

Fig. 4. Reduction of a granitic mountain to mounts, knobs and nubbles.

ment (1897, 92:4), although when it arches over a fully degraded highland, it occupies no such subordinate position as pediment implies. This term should therefore be used only for young, relatively narrow, uncompleted rock floors. It is true that, when stripped of its detrital cover in consequence of erosion following crustal movement or climatic change, the outer part of a bared rock floor ascending with a steeply convex frontal slope may have something of a bench-like appearance, and I have described a discontinuous bench of this kind on the western side of the Santa Catalina Mountains in southeastern Arizona (1931); but after the degraded surface acquires greater breadth and especially after it extends completely over a dome summit, the term, bench, seems less acceptable than the more non-committal binominal, rock floor, because the word, floor, although commonly used for level surfaces, is also applied to uneven surfaces, such as the floor of the ocean.

Moreover, while the lower part of a degraded rock floor is, truly enough, in the earlier stages of its production, covered with detritus as fast as it is developed, its upper part may remain bare through the later stages of growth, except for transitory veneers of shifting waste; and "suballuvial" must then be replaced by "subaerial." So it is replaced by Lawson, although he gives, to my reading, too much emphasis to the persistently suballuvial condition of the bench in certain statements; for

example, when it is said that until the last summit knobs are consumed "the suballuvial bench is, at all stages, buried" (34:4); again, as soon as "the rock crest [of unreduced knobs and nubbins] vanishes," the resulting surface "is, in its ideal completion, wholly one of aggradation, a vast alluvial fan" (33:4), as if the "suballuvial bench" were not visible at that stage of the cycle.

Fortunately an opposed statement is made on a later page. "In the late stages of the recession of the subaerial front, when its height is relatively small, and the embankment is relatively broad, the latter rises very slowly by increments that are nearly equal [all over its surface]; and the hyperbola [such being the theoretical profile of the rock floor] approaches very closely to a straight line and to tangency with the surface profile of the embankment. The profiles of both the bench and the embankment, though mathematically distinct, are then practically coincident. Under these conditions the horizontal [up-slope?] extension of the embankment does not keep pace with the recession of the subaerial front. Between the upper [feather-] edge of the embankment and the base of the front there is evolved a graded rock slope. The suballuvial bench becomes at this stage a subaerial bench, across which the detritus from the vanishing front is swept by sheetfloods in times of cloudburst, to be spread over the surface of the embankment below. This emergence of the bench and its persistence as a subaerial feature appears to be most characteristic of granite ranges" (37:8). Then follows the passage already quoted regarding the "bare rock surface extending.... without appreciable change of slope to... the crest" (38:2), which should therefore be, under Lawson's explanation, a "low rock ridge with symmetrical slopes" (31:7); but under my explanation, a low rock arch.

Embankment does not seem a fitting term for the long-sloping detrital cover which, either heading at the base of a moderately retreated mountain face or feathering out up-slope on a broadly developed rock floor, slants forward very gradually with a faintly concave profile to a playa basin or a river valley. Bahada[9] would be, as a relative of playa, a good name for this highly characteristic feature of the desert landscape; but unfortunately in its original Mexican use this term does not discriminate between the bare rock floor and its detrital cover. When the term is used

[9] An English form of spelling here replaces the Spanish, bajada, just as Mohave now replaces Mojave and canyon replaces cañon, in order to secure an approach to their Spanish pronunciation, and to avoid the unhappy loss of that pronunciation which has taken place in the fine word, mispronounced Cordillera, due to its not having been respelled Cordilyéra.

Fig. 1

Fig. 2

Figs. 1, 2. Looking west and east across slightly dissected rock floor of Granite Mountains. (Photo by Storrow)

here it will, experimentally following Blackwelder, refer only to the detrital cover.

A singular feature of a bahada, when viewed from the level floor of the playa to which it commonly descends, is that the nearly level slope of its lower part seems to be followed at an angle by the apparently much steeper but in reality gently inclined slope of its upper part, as in Plate 14, Fig. 1. Yet no angular bend but only a very gradual increase of acclivity is found as the long concave slope is ascended.

Panfan or Dome. Following his interpretation of the problem, Lawson names the completely graded rock floor of a worn-down mass a "panfan," because, as already quoted, he takes its surface to be, "in its ideal completion, wholly one of aggradation, a vast alluvial fan" (33:4). But this is a partial statement of the case, applicable if at all only to degraded masses of small area and of questionable application even there, because in their penultimate stage, when the summit ridges are diminished to small size, the upper part of the rock floor, where it is slightly robbed, must become bare. The term is still less appropriate for larger masses, although in lack of another name I have used it for them in an earlier essay (1925); for in such cases, as Lawson himself recognizes, the upper part of the floor is, again as already quoted, a "bare rock surface" (38:3). Inasmuch as the bare surface cannot be a blunt-angled ridge or cone but must be more or less rounded off at the summit, the less specific term, dome—or arch for elongated masses—seems preferable to panfan because, while suggesting convexity of profile, it applies quite as well to a convex mass of smoothly degraded rock as to one in which the degraded rock is covered with alluvium. And since the term, dome, is here used for forms of undisturbed degradation on massive crystalline rocks, it should not be confused with salt domes of subterranean deformation, such as occur in Texas and elsewhere.

The occurrence of broadly convex domes is, however, fully recognized by Lawson, even though he calls the type example of such forms a "mountain ridge" (26:7); but the manner of their production is not clearly stated. Brief note is made to the effect that what is here called rock-floor robbing causes a modification of an already produced, blunt-angled panfan (44:5), and that this "modification would be manifest as a transfer of finer material from higher to lower levels;" also that this "process would of course be in operation long before the panfan stage, particularly when cloudbursts were local to the fan slope and did not affect the subaerial front" (44:5, 6). But the effect of the process in changing the nearly

rectilinear profile of a graded surface to a broadly convex profile before the panfan stage is reached is not explicitly brought out.

It is, on the other hand, implied that the development of rock-floor convexity, which must be accomplished by the erosion of the rock floor, is postponed until after the mounts and knobs along the summit of the slope have vanished; but that seems, as already intimated, impossible, because the change of sheetflood action from transportation alone to erosion and transportation together cannot be so long delayed. The change should have begun gradually as soon as the diminution of rock-face area causes the volume of detritus that it sheds to fall below the measure that the piedmont sheetfloods can transport. Hence a convex arch or dome and not a blunt-angled panfan is the normal form of a degraded granitic mountain in the desert. Such a convex form should be seen for a time before and enduringly after the sharp, ungraded ridges, mounts and knobs of the summit, with their bare rock faces, are all consumed.

But the graded dome is evidently not a final form. The very processes by which its convexity is initiated continue after its completion to degrade it to lower and lower convexity. I must therefore dissent in several respects from Lawson's statement concerning the "panfan stage of the geomorphic cycle of the desert," where he says: "The panfan may be regarded as an end stage in the process of geomorphic development in the same sense that the peneplain is an end stage of the general process of degradation in a humid climate. The peneplain closes the cycle of degradation and is a cut surface; the panfan closes a cycle of degradation and aggradation, is evolved by both cutting and filling, and is a built surface" (33: 5, 6).

On the contrary, a panfan when first developed is no more an ultimate form than a peneplain is. The degradational processes by which both forms are produced continue to operate, although the rate of their operation is retarded. I would therefore modify Lawson's statement, "with the disappearance of the rock crest the process of degradation changes from one of relative rapidity to one of extreme slowness" (32:7), by pointing out that, when rock-floor robbing is recognized, the degradation of the growing area where robbing operates was very slowly going on before the disappearance of the rock crest. Again, it is said that the vanishing of the rock crest marks "a stage of geomorphic development at which the processes of aggradation and degradation, in so far as they are due to the agency of water, both almost cease" (32:6); but it may be better said that those processes then still continue the slower and slower

action, as far as the graded surface is concerned, that has long been slackening.

Furthermore, a fitting supplement to Lawson's analysis might carry its elaborations a little farther by considering the case of an upheaved granitic mass in a littoral desert, like that of southwest Africa which Kaiser has so well studied, and showing that the playas of interior deserts may be there represented by the unfillable ocean, so that an upheaved granitic mass might in such a region be degraded to a dome with respect to the standard baselevel or ocean surface, with negligible aggradation around its margin; and such a dome would correspond to a peneplain which is developed wholly by degradation. But the case of the peneplain might also be elaborated from its most elementary form in which all of an uplifted surface originally stands above baselevel, so as to include the more general case of an unevenly uplifted surface, part of which is occupied by low-level basins which must be aggraded up to a peneplain surface while the higher parts are worn down to it. In the first of these cases, the playa-less panfan is wholly a cut surface, like the elementary peneplain; in the second the peneplain is a cut-and-filled surface, like the ordinary panfan and its playas.

In view of these somewhat carping criticisms, it is a satisfaction to read on a later page of Lawson's essay a revision of his above quoted statements about peneplains, comparable to the other revision in which the existence of "bare rock floors" is recognized (37:7) after earlier insistence that rock floors are always covered with detritus (33:4, 34:4); namely, "the peneplain is, as the term implies, a penultimate rather than an ultimate stage of geomorphic development under persistence of uniform conditions. The final stage is a plain. . . . . Similarly the panfan is a penultimate stage in the reduction of the relief of the desert under conditions of crustal stability" (44:1).

The Boulder-clad Mountain Face. The persistent steepness of the retreating, boulder-clad face of a desert granitic mountain has been fully explained in Lawson's essay and need not be further discussed here. The face may be regarded as roughly graded, as I have pointed out in an earlier article (1930, 147), in which its barren surface with scanty soil and practically no vegetation is compared with a graded and forested mountain side in a humid climate, the slopes of which are so well soil-cloaked that the sub-soil boulders of disintegration are completely concealed. In both cases the slopes have acquired such declivities that the local agencies of

transportation are nicely adjusted to the work that they have to do. It may be added that in these steep mountain faces, just as on the sides of narrow gorges and canyons, in bold cirque heads, precipitous caldera walls and steep sea cliffs, the efficiency of joints in guiding the attack of the weather is manifest and unquestionable, however inefficient they are in giving supposed guidance to the course of graded streams in winding valleys.

The abrupt transition from the steep and roughly graded face of a desert granitic mountain to its gently sloping and well graded rock floor, whether covered with detritus or not, has been specially treated by Bryan, who shows that it is chiefly the result of the correspondingly abrupt transition from the large boulders which linger on the steep face to the granular detritus which, after being washed down from the face, has to be swept down the graded piedmont slope. The rarity of head-, fist- or nut-sized rock fragments on both the steep face and the graded floor is surprising, until it is understood that the disintegration of the smaller boulders reduces them directly into granular detritus. The small rock fragments that are occasionally found on granite slopes are usually angular scraps of quartz veins or of aplite intrusions. The same observer emphasizes the persistence of constant slopes in diminishing granitic mountains: "Solitary .... hills retain the same steep slope as the original mountains, but grow gradually smaller until the last remnants are masses of boulders or single rocks projecting above the general level" (1925, 96).

In mountains made of rocks which, unlike granite, weather into angular blocks, scraps and grains of all sizes, the transition from the steep upper slope of the retreating face to the gently sloping rock floor is, again as Bryan has shown, not made abruptly in a sharp bend of the profile, but is gradually accomplished in a sweeping curve. The contrast between such a curve and the abrupt change of slope in granite mountains, Fig. 10, is so striking that W. Penck's categorical denial of the occurrence of a basal angle (1924, 157:8) is hardly warranted; for it must of course be understood that, just as an angle in a road is of engineering quality, a mountain-base angle is of a geographical rather than of a geometrical quality.

Valleys in Arid Granitic Mountains. It is to be expected that, in spite of the prevalence of arid conditions, the highland surface of an upheaved land mass must be traversed by wet-weather streams along valleys of pre-upheaval erosion, or along new courses consequent on that surface as modified by deformation; also, that such streams must incise trenches in

the upheaved surface and thus, in cooperation with the weathering of the trench walls, develop valleys which will in time consume all the original highland surface, in so far as it is not consumed by the back-wearing degradation of the original marginal scarps. This expectation is supported by the rarity with which any trace of the pre-upheaval surface can be detected in the present-day highlands of desert mountains because of their well-advanced dissection. Apart from a few Louderbacked ranges, the Paso Mountains,[10] recently uplifted along the Garlock fault, and the near-by Rand Mountains are the only ranges I have seen in the region in which the pre-uplift form is still easily recognizable.

The share taken by highland streams in the sculpturing of desert mountains is hardly discussed in Lawson's essay. It is briefly noted that "corrasion by running water is quite a subordinate part of the [degradational] process except in those ranges which are so high as to have a relatively abundant precipitation upon their summits" (28:4). "Acute indentation of the contour of the subaerial front" is said to "inhere chiefly in the heterogeneity of the mountain mass" (46:6); streams are not mentioned in that connection.

Bryan places a much higher value upon stream erosion. He writes: "The pediment is greatly increased in extent by the lateral migration of streams at and below the mouths of canyons. Extensions of the pediment into the mountains are common. These extensions consist of branching valleys, many of which are two miles or more in width and reach far into the interior of the mountain mass" (1925, 96, 97). He notes also that "residual hills are strung out [on the pediment] in lines between the original canyons. When the [inter-canyon] spurs become narrow they are cut through by slope recession on both sides, and hills are left standing as outliers on the pediment." Many of these hills are "prolongations of the inter-canyon ridges" (1925, 89, 94, 96), as is shown by his contour map of the Sacaton Mountains and their well developed peripheral rock floor in southeastern Arizona.[11]

Degradation of Non-Granitic Mountains. The forms assumed by non-granitic, mountain-making rocks differ from those of granitic moun-

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10 The name, El Paso, for these mountains is objectionable because it commonly results in their being called "The El Paso Mountains," which is absurdly redundant. The Spanish article is therefore omitted.

11 A question suggested by the above quotation, as to how far the canyon mouths are widened by the lateral erosion of migrating or swinging streams, will be discussed in my other paper, Sheetfloods and Streamfloods, referred to above.

tains because of their less homogeneous structure and of their different manner of disintegration. Instead of retreating from their original form in fairly simple faces, not deeply cut by valleys, they retreat irregularly and valleys are soon opened along their lines or belts of weakness. Instead of changing abruptly from a steep, craggy and bouldery face to a graded piedmont slope, as granitic mountains do, they change, as already told, from roughly graded but somewhat ledgy faces by a smooth concave curve to a graded piedmont slope, as Bryan has well shown. And instead of maintaining faces of essentially uniform declivity during their retreat, the faces tend to assume a gentler and gentler declivity as their cores of more resistant rock yield less and less coarse detritus in virtue of being more and more encroached upon by graded slopes.

The detrital fans formed at the valley mouths are much more prominent than the corresponding piedmont fans of granite mountains, because here the detritus in the fans is relatively coarse, and therefore their gradient is steep, their heads rise high above the base of the inter-fan mountain face, and their outspreading fronts advance far upon the elsewhere gentler gradient of the detrital slope.

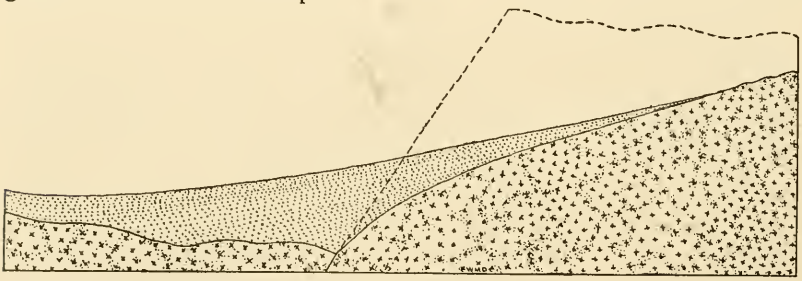

Fig. 5. Reduction of a non-granitic mountain to a group of mounds.

In their penultimate stage, Fig. 5, mountain masses of this kind are reduced to groups of low mounts or hills, each of the many members of a group having a somewhat ledgy crest where the resistant rock core which determines it feebly outcrops. It is to be inferred that the mount or hill having the most resistant core will dominate the other members of its group. The upper parts of these residual forms show little tendency to develop convex slopes, except just over their tops, presumably because the somewhat coarser detritus shed by the summit cores prevents the degradation of the upper slopes to a diminishing declivity. These mountains therefore show, in the penultimate stages, more ridge- or cone-like forms than granitic mountains do.

PART II. EXAMPLES OF UNFINISHED AND FINISHED GRANITIC DOMES

Subdivisions of the Mohave Desert Region. The Mohave Desert region includes, in its extent of some 250 miles west-east and 150 miles north-south, a large number of irregularly spaced mountain masses or ranges, unlike in structure, area, pattern, height and stage of arid erosion. They alternate with correspondingly irregular intermont depressions or troughs, more or less heavily but always smoothly aggraded with waste from the mountains, which overlaps on their piedmont rock floors. The rock bottom of each trough, at depths of 1000 or 2000 feet below the present surface of its detrital filling, is probably as uneven as the originally upheaved rock tops of the bordering mountains, so that each depression then contained separate basins, just as the mountains originally exhibited separate summits. But while the original summits have been dissected into innumerable peaks, many of the original basins have been unified by aggradation in continuous trough floors, on which flat fans form low divides between shallow playas; thus anticipating the simplicity of the peneplains to which the mountains will be degraded when they show only low mounds between shallow swales. Unlike the more linear Basin Ranges farther northeast, which generally trend north-south, the mountains of the Mohave Desert have no systematic arrangement; and perhaps for that reason no agreement upon a subdivision of the region has been commonly reached. It is therefore here proposed to subdivide it somewhat arbitrarily into a number of districts, the names selected for which as well as those of the chief towns are given in Fig. 6. The reader will find it to his advantage, when looking over the following pages, to bear in mind the localities there named.

Examples selected for Description. The following account of several unfinished and finished granitic domes or arches is concerned particularly with the evidence that they furnish with regard to the occurrence of blunt-angled crests, according to Lawson's explanation, or of rounded crests, according to the modification of his explanation here presented. The examples selected for description probably differ from many others chiefly in the purely subjective quality of happening to lie so near highways or roads that they are easily reached. The mention of most of them therefore does not mean that they are objectively exceptional in giving better illustrations of the work of arid degradation than their neighbors, but only that they are the best examples of their several kinds that I have been able to visit. The origin of the ranges by faulting is not often directly

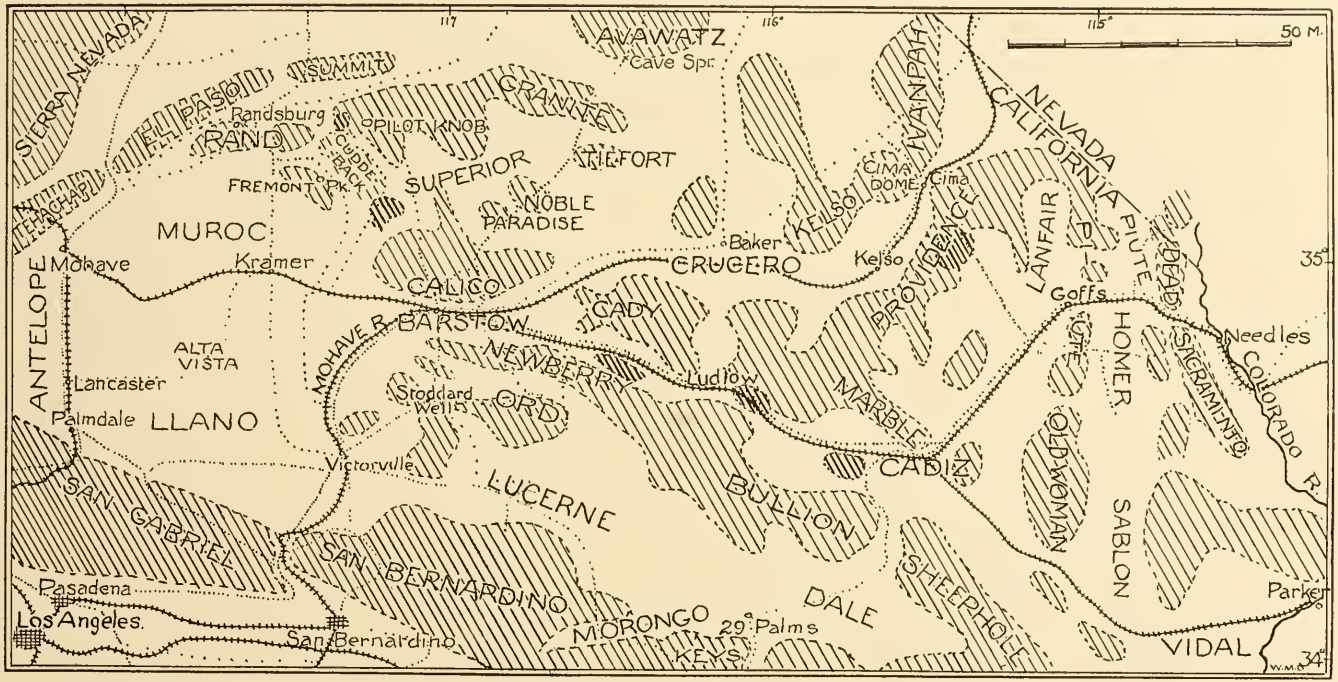

Fig. 6. Outline map of the Mohave Desert region. Its chief divisions may be named as follows: In the west a broad plain known as Antelope Valley. Next to east the Muroc-Llano district; at its mid-eastern salient lies Barstow, a center for locating other points. On the northeast is the Superior district, about 50 miles across; on the southeast is the extensive Lucerne-Dale trough. Between these, two long irregular troughs, united at Barstow, lead east-northeast and east-southeast. The first or Crucero-Ivanpah trough is followed by the Los Angeles-Salt Lake line of the Union Pacific Railroad; a branch trough turns from it to Death Valley. The other or Ludlow-Cadiz trough, followed by the Santa Fe Railroad and locally floored with recent lava flows, branches at the large Bristol playa, the Cadiz-Lanfair trough trending northeast, and the Cadiz-Vidal trough trending southeast. These branches are separated by the Old Woman and other mountains, beyond which the Homer-Sablon trough connects them; its northern part or Piute trough is crossed by the Santa Fe Railroad in its descent to the Colorado River near Needles.

provable; but the Marble Mountains, Fig. 7, north of Bristol playa, show a manifest discordance of baseline to monoclinal structure; and farther northeast the northern part of the Piute Range is thinly Louderbacked, as in Fig. 8, thus indicating that upfaulting has been concerned in the production of these two ranges at least; also that for the second example and therefore probably for many of its neighbors, the district had been reduced to low relief before upfaulting took place: in other words, the district was then a part of the vast "Powell surface."

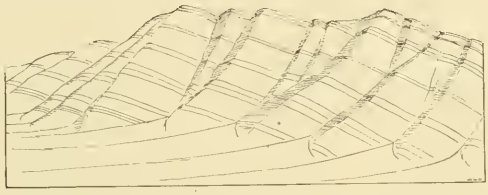

Fig. 7. Dissected fault scarp of Marble Mountain.

The occurrence of many rugged mountains interrupting the desert's broad expanse shows that their upheaval has been too recent to permit their reduction to completely graded, penultimate forms; but the long, smoothly graded slopes which flank many of the ranges, giving them fan-dented or fan-bayed patterns, show that since their uplift, a somewhat prolonged period of rest has permitted a good advance in their cycle of arid erosion. Some of the ranges still reach far down toward the flat axial

Fig. 8. Louderbacked scarp of the northern Piute Mountains, looking west.

floors of the aggraded intermont troughs, where they are wrapped around by floodsheets of detritus from their less salient parts; others have receded until they occupy only a minor part of the highland by which two intermont troughs are separated; and occasionally the floodsheets of detritus, doubtless concealing a graded rock floor at less and less depth for much of their ascent, rise towards a smooth skyline arch which, as in Fig. 9, replaces a degraded range. With the probable exception of those which ascend to or nearly to a crest line, these graded slopes exemplify the correctness of the Paige-Lawson principle that rock floors are covered with detritus as fast as they are produced. Most of the upper slopes are of astonishing rectilinearity, as shown in Fig. 10.

It should be noted that, as McGee pointed out (1897), the graded slopes are not drained along inbranching stream courses, such as prevail in the sharply dissected, residual mountains, but by broad sheetfloods, whose shallow and elaborately enmeshed lines of flow cover the surface with their intricate network. It is only where two sheetflood slopes converge obliquely that a true stream is formed along the line of their junction. True, some of the flow-lines of sheetfloods may continue here and there in stream-like form for several hundred feet or more, but they are sooner or later subdivided and distributed in enmeshed fashion. Even the

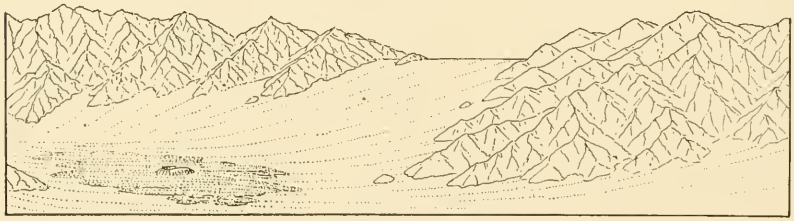

Fig. 9. Generalized features of the Mohave Desert.

trough floors, where it might be expected that streams would be formed by the union of sheetfloods from the two sides, are usually so flat that their drainage lines are of a braided habit, closely resembling the enmeshed pattern of sheetflood flow-lines. It is only when, for whatever reason, a graded surface is dissected that its enmeshad sheetflood drainage is converted into an inbranching drainage system, as will be shown in my other paper on Sheetfloods and Streamfloods.

Further exploration of the desert should surely bring to light many other good examples of the processes of arid degradation than those cited below; but it is felt that few if any will equal in smoothness of convex profile the beautiful Cima Dome, Plate 12, or the majestic Cuddeback Arch, Fig. 23.

The Granite Mountains. One of the best examples that I have seen of a graded but unfinished granitic rock floor below a bold mountain of back-wearing development flanks the Granite Mountains where they are crossed by the Cave Springs road, nearly 50 miles northeast of Barstow on the way to Death Valley. A rough sketch of the mountains and their graded piedmont slope, as seen from near Bicycle playa on the south, is given in Fig. 11. The road ascends the long slope a mile or more to the east of a south-stretching spur, in order to reach a narrow notch or pass in the range crest. The slope is largely covered with detritus, a true bahada,

as it very slowly rises from the level playa surface and gradually steepens to an acclivity of 4° or 5° before reaching the rather sharply defined base of the craggy and bouldery mountain face; but the last half mile of the ascent shows many rock exposures, particularly for a part of that distance where, for an unknown reason, it has been slightly dissected after having been well graded, as in Plate 13, Figs. 1, 2.

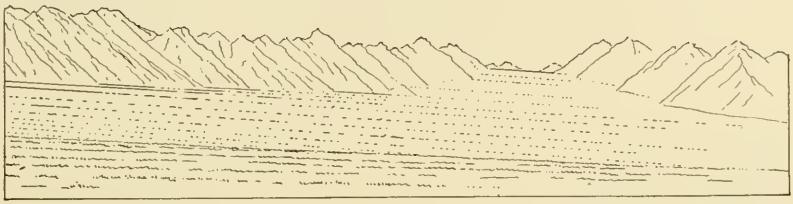

Fig. 10. Angular junction of craggy granitic mountain faces with rectilinear detrital slopes. Bullion Mountains, looking west.

The walls of the narrow pass are high, steep and rocky, like the mountain face to the east and west; and the steady acclivity of the rock floor continues into the pass and almost to its very summit, evidently because a good supply of waste is still shed there from the high walls. Yet the actual summit is not blunt-angled, but is arched over for a 100- or 200-foot distance; and this is taken to justify the inferences presented above in the fourth paragraph of the section on Rock-floor Robbing. Another inference here finds application; namely, that this much diminished mountain mass was originally a fault-block; for otherwise it could not have developed steep faces; but this inference finds no independent verification.

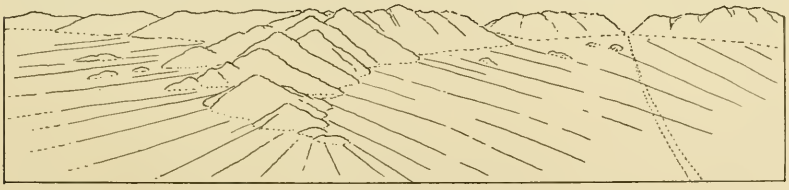

Fig. 11. The Granite Mountains, looking north.

The southward-advancing spur of the range, Fig. 11, has several rather well defined indentations, which are more probably explained by an increase in the number of joints than by a change in the nature of the rock; they mark a slightly less resistance of the mountain face under the attack of the weather, which is to be measured not by the amount of their recession back of a line connecting the adjoining salients, but by the small excess of their total recession over the slightly less recession of the salients

from the original scarp of the mountain mass, which may have been several miles away. Some of these indentations, where the ridge crest sagged to less than its average height, have been worn through in open passes, the walls of which are lower as well as farther apart than those of the narrow summit pass followed by the road. One of the open passes was reached on foot by some of my students, who found it to be distinctly convex on a cross profile for about a quarter mile. This is taken to give further confirmation for the paragraph above referred to.

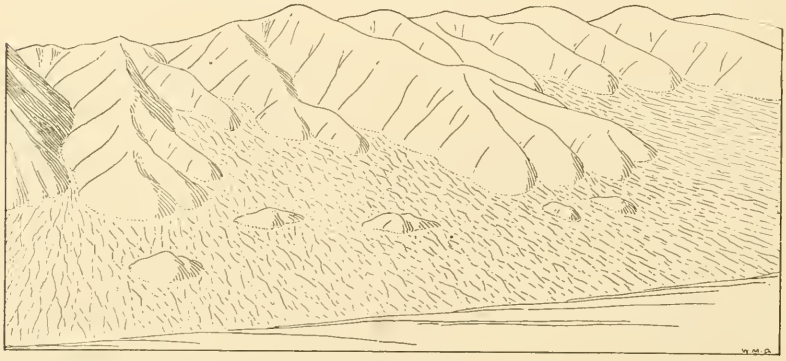

Fig. 12. The Paradise Mountains, looking southwest.

The northern face of the Paradise Mountains, half way between Barstow and the Granite Mountains, is outlined in Fig. 12, as seen from the Cave Spring road several miles to the northeast. It shows a fan-bayed stage of back-wearing degradation, of more irregular pattern than that of the Granite Mountains. Where its long bahada meets the bahada of the Noble Domes, next to the north, a stream course or "wash" is well defined.

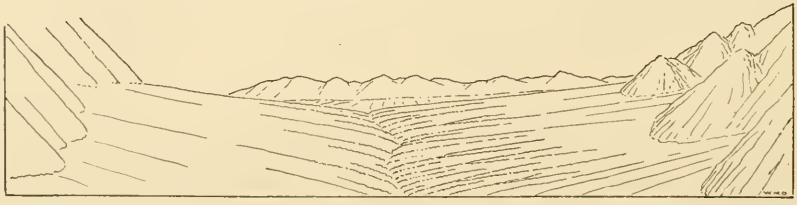

Fig. 13. Pass between Bullion and Sheephole Mountains, looking southwest.

The Pass between Bullion and Sheephole Mountains. A pass, Fig. 13, about 4 miles wide, separating the granitic Bullion and Sheephole Mountains, is traversed by a desert road from Bristol playa in the Cadiz

trough to the eastern part of the Lucerne-Dale trough. The broad crest of the pass is occupied by well developed rock floors sloping away from the bold terminal faces of the mountains toward a midline, along which clearly defined stream courses descend to the northeast and to the south; the latter being deflected from an expectable southwest course by a long and low spur of the Bullion Range. If sheetfloods had acted there only as transporting agencies the two slopes from the pass crest should be rectilinear and its cross-profile should be blunt-angled, as shown by the dotted line in Fig. 14. But as a matter of carefully observed fact the crest is broadly arched, as shown by the full line. Hence the sheetfloods must have acted there both as transporting and eroding agencies. It is, indeed, reasonable enough that they should have so acted near the crest, because before the pass was opened the originally continuous mountain mass must have been narrowed to a lowering ridge, the detritus from which could not have loaded the floods to capacity; moreover, the supply of detritus from such a ridge could not have been significantly increased by that from the retreating mountain faces on either side, because the slopes at their base would curve away from the pass toward the still lower slopes on either side of it.

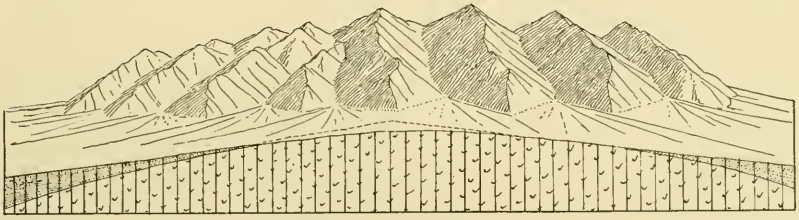

Fig. 14. Pass between Bullion and Sheephole Mountains, looking southeast.

For some unexplained reason the upper part of the northeast stream course has been rather sharply incised to a depth of about 20 feet, the detrital cover of the adjacent rock floors has been stripped off and the floors have been slightly dissected, as shown in Plate 14, Fig. 2; but the cover remains near the mountain scarps on both sides of the pass. The stripped floor here developed is one of the finest examples of its kind that I have seen.

The Unsymmetrical Storrow Dome. An uplifted granitic mass, from which the outwashed detritus has free discharge in nearly all directions, will develop piedmont slopes with convex contours on all sides. A partial illustration of this principle is seen in the divergent detrital slopes that

sweep around the southern spur of the Granite Mountains, Fig. 11. But a contrasted condition may be imagined, in which the opposite sides of an upheaved mass drain into playas at different distances and different altitudes, so that one of the back-wearing flanks of the range will come to undercut the other, as in Block 2 of Fig. 15. Not until a later stage of retrogression will the rocky face that separates the two slopes be consumed, so that they can meet in a rounded crest, Block 3. An example of

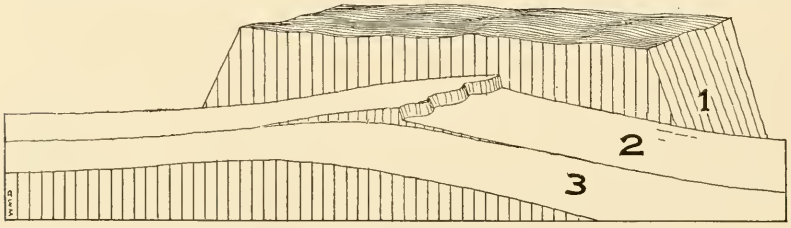

Fig. 15. Development of a scarped half-dome.

this kind occurs in the southern part of the Superior district, 13 miles north of Barstow: it is included in the southwest corner of the Avawatz sheet of the U. S. Topographic Map. A road that leads north from Barstow to the east side of the Cuddeback Arch, described below, crosses the western side of this dome, which I have called the Storrow Dome, after my companion on the two excursions which passed over its western side. Its half-domed surface, bearing scattered Joshua trees and so completely degraded that it shows no knobs or nubbins, slopes smoothly and gently northward from a convex, east-west crest which culminates at an altitude of 4100 feet; it drains to one of the playas, perhaps 10 miles from the crest,

Fig. 16. South-facing scarp of the Storrow half-dome.

in the Superior district at an altitude of about 3500 feet. The south-facing scarp, Fig. 16, about 3 miles in length, has a height of from 300 to 600 feet and a slope of 30° or more, and is varied by alternating salients and entrants of moderate measure. A well graded detrital slope, beginning at the base of the scarp at an altitude of about 3500 feet, drains southeast to the Mohave River east of Barstow, 15 miles away, at an altitude of 2000 feet. The difference of altitude between the two local baselevels thus

amounts to 1500 feet, and therefore suffices to account for the unsymmetrical form of the dome. Although granite boulders are seen here and there, the scarp is not craggy but smoothly graded and its basal profile is curved.

An Unsymmetrical Member of the Bullion Mountains. A less mature example of unsymmetrical degradation, differently conditioned from the Storrow Dome, is found in a branch of the Bullion Mountains which overlooks the broad Bristol playa of the Barstow-Cadiz trough from the southwest and which adjoins the above-described pass on the northwest. The northeast face of the branch-range, draining directly to the playa, rises boldly from the detrital deposits at its low base directly to the high crest, as in Fig. 17; but the southwest face, which consists of irregular

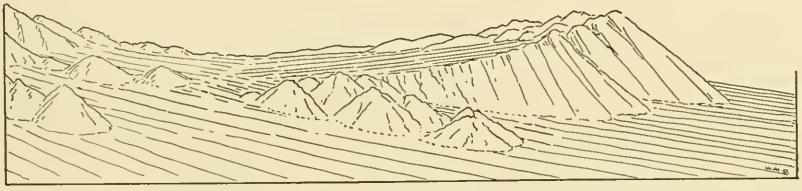

Fig. 17. Unsymmetrical degradation in the Bullion Mountains, looking northwest.

knobs of small relief, rises from an opposite detrital slope, the head of which has ascended to a considerable altitude because of the long course of its sheetfloods around the southeast end of the branch-range to the same playa. As the northeast face retreats farther and farther, it will consume more and more of the present crest and of the detrital cover behind it, until it undercuts the main range, 3 or 4 miles to the south. The desert probably contains other examples of this kind in earlier or later stages of degradation, but none that I have seen is so striking as this one.

The Kelso Mountains. An instructive group of back-wearing granitic mountains and unfinished domes is shown on the Ivanpah sheet of the U. S. Topographic Map on a scale of 1:250,000, with 100-foot contours. It rises along the northwest side of the Crucero-Cima trough, which is followed by the Union Pacific Railroad in a long upgrade. The largest mass of the mountain group occupies an area of about 5 by 6 miles and culminates in Kelso Peak with an altitude of 4746 feet. It is followed for 10 miles northeastward by other mountains of less size and height, the graded passes between them having altitudes of 3500 or 4000 feet. Still farther to the northeast is the finished Cima Dome, Plate 12. The fine

highway that connects Los Angeles with Salt Lake City via Las Vegas, Nevada, passes 10 or 15 miles farther north; a good cross-road over the eastern side of Cima Dome connects the highway with the railroad.

The western part of this mountain group was seen only from a distance of several miles to the south. The irregular mountain faces advance in many points and retreat in as many bays, most of which have ragged or frayed-out patterns and therefore served me as types for the fan-bayed and fan-frayed stages of mountain retreat in an earlier paper (1925). As the ragged mountains are traced northeastward they diminish in size and height; then even the diminished residuals disappear and the graded slope, which farther west stopped in the bays, ascends to the crest and seems to arch over it. The crest, which has an undulating skyline, deserves to be examined more closely in order to measure the breadth of its convex profile; but I am persuaded that the convexity begins before the lowered rock residuals come to an end and then continues after they disappear. In view of the strong rock faces of these mountains, it would seem probable that they originated as upheaved fault-blocks, and therefore deserve to be classed with Gilbert's Basin Ranges.

The Cima Dome. One of the most profitable lessons of this district is found in the continuity of the undulating and apparently convex crest from the ragged Kelso Mountains northeastward to the perfect Cima Dome; for in the absence of a retreating rocky face on that dome, one might be uncertain, as long as it is considered alone, whether it had been produced by back-wearing or by down-wearing degradation. But the strong though ragged rocky faces in the Kelso Mountains make it clear that they are in process of back-wearing degradation, and their close relation to the Cima Dome, as well as their direct connection with it by what may be regarded as a series of closely confluent domes, leaves no doubt that it is a completed product of the same back-wearing process that they are passing through. Hence it, like them, probably began as a fault-block.

The convexity of the dome, Plate 12, is so perfect that it may be said to realize an ideal. My first sight of it was from the railroad, which passes close along its southeastern side, in 1925. It was visited in the spring of 1932 with Mr. Storrow, when several trails, not too rough to be followed by a strong and well driven car, led us up some of the slope lines toward the broad dome top. The name here given to the dome is Spanish for summit and is taken from that of a near-by railroad station in an open pass at the southern end of the Ivanpah range. The lower detrital slopes

are, like those of the neighboring mountains, dotted over with creosote bush (*Covillea tridentata*), but while the neighboring mountains are relatively barren, the higher arch of the dome is occupied by a forest-like growth of that strange member of the lily family, the "maniacal Briaereus of the desert, frantic with meaningless gesticulations," known as the Joshua tree (*Yucca arborescens*), with which junipers, always spoken of as "cedars" in the arid west, are associated. The summit of the dome has an altitude of 5710 feet; its contours, Fig. 18, are roughly circular; the

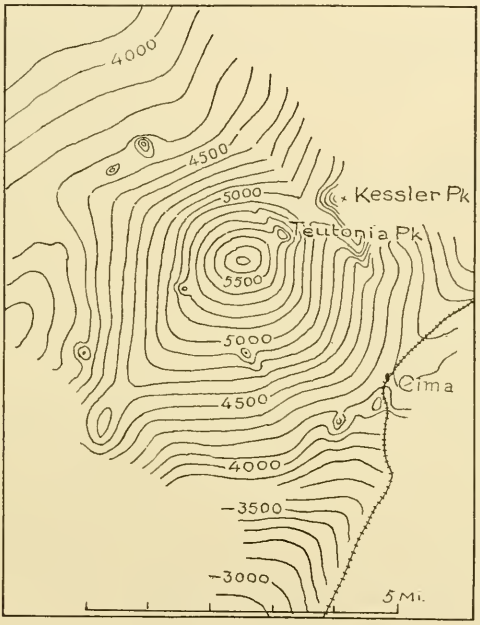

Fig. 18. The Cima Dome, from Ivanpah sheet, U. S. Topographic Map.

diameter of its circuit at the 4500-foot contour is a little over 4 miles. Teutonia Peak is a good-sized residual mount on its eastern side. Several smaller knobs and a multitude of bouldery nubbins, Fig. 19, are scattered like roc's eggs, over its crest and slopes; a few softly rounded residual mounds, Fig. 33, of aplite or other fine-textured rock are also seen here and there. The concave flanks of the dome are built up with detritus, but by far the greatest part of its convex surface is a smooth top of weathered rock. Kessler Peak, 6152 feet in altitude, the southernmost outpost of the Ivanpah range, rises near-by on the east. Three springs are mapped on the dome at altitudes of 5020, 5150 and 5350 feet. It seems probable that

their emergence is guided by joints in the granite and that they therefore stand above the margin of the detrital cover. If so, the height of the dome summit above the cover margin would be 500 or 600 feet, and the dome diameter at the cover margin would be about 2 miles.

The slopes, which hardly exceed a 4° declivity at their steepest part around the circle of inflexion between the convex top and the concave lower slope, do not show true stream courses, but are faintly channeled by the innumerable enmeshed flow-lines of sheetfloods. These floods must,

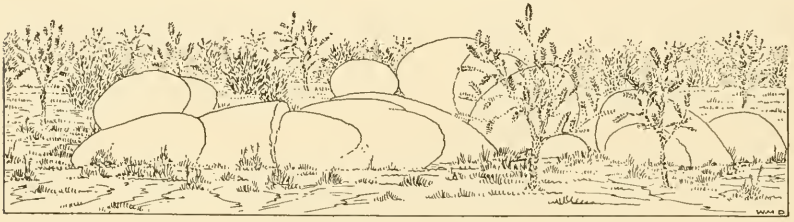

Fig. 19. Residual granite boulders near summit of the Cima Dome.

as a rule, spread to greater and greater width as they run down the diverging lines of slope, and the spreading must be most rapid near the dome top. But where the convex contours on the northern slope of the dome meet the contours on the northwestern slope piedmont to Kessler Peak in inturning angles, a true stream has excavated a well defined channel in the alluvium; for there, as is usual in such locations, sheetfloods from the two slopes must converge and join forces in a linear stream.

This beautiful dome is so broadly convex that its highest point is difficult to locate. It is very unlike a ridge, for there one identifies the upper edge, where ascent stops and descent begins, easily enough. On mounting to such an edge, one finds that it is at once a case of *ne plus ultra,* as far as altitude is concerned. But on so broad and perfect a convexity as that which the Cima Dome possesses, one wanders about uncertainly as the top is approached, because the direction of the final ascent there is more and more difficult to determine. While pushing on one repeatedly thinks the top must lie where the gentle convexity of the surface, as seen through the scattered trees, carries it out of sight a few hundred feet ahead; yet on reaching the line of its disappearance no summit is found, but only more convexity. The ascent of a dome is therefore almost a case of *semper plus ultra;* and for that reason I did not reach the summit.

An appreciative description of the dome has been written by Thompson in his account of the Mohave Desert region, as follows: "Northwest

of Cima the land rises with a rather gentle uniform slope, like an alluvial slope, to a nearly dome-shaped summit. . . . Many outcrops show that [the upper part of] this dome is composed of granite and is not an alluvial slope, as it appears to be, but an erosional slope or mountain pediment beveled across the bed rock. It may have a thin veneer of alluvium on top of it, but at most this is only a few inches or a few feet thick. It is difficult to tell where the alluvial slope [which is hundreds of feet deep in the near-by valleys as shown by wells] ends and the erosional slope begins, for the decayed granite in place is much like the soil of the alluvial slope" (1929, 550, 551). Lawson's brief mention of the dome as a "mountain ridge . . . . almost completely buried in its own alluvial waste" (26:7) is therefore inadequate.

It has been suggested above that, in view of the neighborly relation of the finished Cima Dome to the Kelso Mountain group with their striking rock faces, the dome is a completely graded part of a Basin Range fault-block, which may very well have included the Kelso Mountains also. It may be added that the occurrence of a fault scarp buried under the detrital cover on one or the other side of the dome may perhaps be determined by the penetrating devices of modern geophysics; also that, in view of the broad convexity of the dome, its original highland surface, which may be regarded as an early uplifted part of what I have called the "Powell surface" of the Great Basin region (1925), was not much higher than its present summit; also that sheetflood erosion, from which all of its convex slopes have long been suffering, has somewhat degraded not only its rock floor but probably its detrital cover as well, so that the overlap of the cover is now less than it was formerly. These are extensions of the inferences based on the general principles developed above, in the section on Rock-floor Robbing.

Perfect as is the convexity of this beautiful dome, it does not completely demonstrate the truth of the principle that the production of a convex profile begins during the later stages of mountain degradation, when the residual ridges and knobs are reduced to so small a size that rock-floor robbing sets in; for it is conceivable that the present convexity of the dome might result from the slow degradation of a blunt-angled cone. Hence it is only because of the apparent truth of the principle of rock-floor robbing that the dome is believed never to have had a blunt-angled summit.

The Noble Domes. The Cave Spring road, between Barstow and the Granite Mountains, crosses several confluent granitic domes which, as

they have no designation on the Avawatz sheet of the U. S. Topographic Map, where they are very imperfectly represented, I have named in my notes after Dr. L. F. Noble, who first guided me there several years ago. This group of domes has been visited three times since then, and a good part of the dome that is crossed by the road has been carefully examined. Much of its surface has thus been found to be delicately marked by an elaborate branchwork of shallow and minute stream courses, quite unlike the enmeshed lines of sheetflood flow which characterize the slopes of the

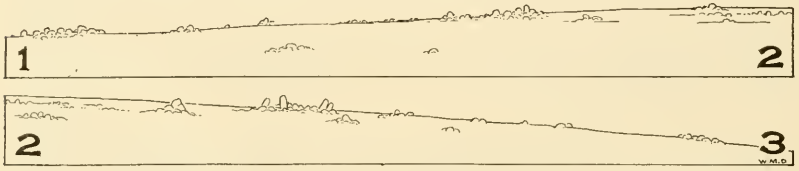

Fig. 20. Profile of the Noble Dome, looking east.

Cima Dome as well as the bahadas of the many less completely degraded mountains in the desert region. Hence, in spite of the nicely developed convexity of these domes, as shown in Fig. 20, they are regarded as the advanced work not of back-wearing but of down-wearing degradation, and their description is therefore postponed to my second paper, where it will be presented as a means of emphasizing the work of sheetfloods by the light of contrast.

Low-Grade Domes between Barstow and Lancaster. The western part of the Mohave Desert, between Barstow and Lancaster, contains a number of low-grade granitic domes of faint but remarkably regular convexity. Residual granitic boulders are sometimes seen on their slopes. Where the domes are confluent, as not infrequently happens, a forward

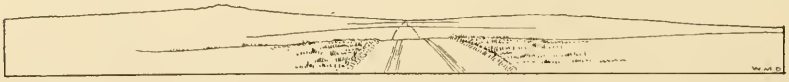

Fig. 21. Low-grade domes near High Vista, between Barstow and Lancaster.

view along a road which passes over them, sometimes on a land-office line, gives an indication of their gentle undulation, Fig. 21, and Plate 15, Fig. 1, which apart from their profiles is not clearly shown in their featureless surfaces. Some of them have been encroached upon by lateral erosion where the Mohave River north of Victorville has widened its flood plain at their expense; gulleys there incised in the steepened slopes as well as

Fig. 1. Deceptive appearance of angular change from lower to upper part of a bahada; Coxcomb Mountains, looking east. (Photo by Storrow)

Fig. 2. Slightly dissected rock floor in pass between Bullion and Sheephole Mountains, looking east. (Photo by Storrow)

occasional roadside cutcrops reveal deep weathered rock or caliche. Some of these domes are delicately carved by shallow, in-branching valley systems, as if they, like the Noble Domes, were the work of down-wearing degradation. However that may be, all of them are in a later stage of their evolution than the Cima Dome, and therefore like it they do not absolutely prove that, at the time when their last residual knobs were consumed, they already had a broadly convex instead of a blunt-angled summit. Further northwest, toward Mohave, broad expanses of the desert are reduced to the faint relief of a well advanced peneplain, except for well-spaced knobs, probably volcanic necks, as in Fig. 22. This area is one of the very few

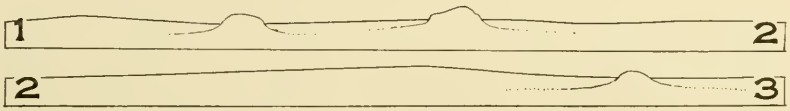

Fig. 22. Undisturbed peneplain in the Muroc-Llano district.

that I have seen in which an undisturbed peneplain is still suffering a continuation of its slow degradation.[12]

Singularly enough, the long repose of this greatly degraded district has not been disturbed by the strong upheaval of the mountain ranges on the north and south. A mile north of Victorville a highway cut shows the outwashed gravels from the southern or San Gabriel Mountains resting on the graded rock floor of an uncompleted dome, over which the granitic Silver Mountain, apparently a northwest-tilted fault-block, still survives; and as that uncompleted rock floor represents a much shorter period of undisturbed degradation than do the completed, low-grade domes to the northwest of it, they must have remained undisturbed since a somewhat remote geological date. It is for this reason that they may be regarded as resembling, if indeed they are not an undisturbed part of, the wide-spread "Powell surface" of advanced degradation, which occupied a vast area from Arizona and Utah across Nevada and well into California, before the upfaulting of the Basin Ranges and of their larger associates, the Wasatch Mountains on the east and the Sierra Nevada on the west.

The Cuddeback Arch. From 25 to 45 miles northwest of Barstow

[12] The advance sheets of the U. S. Topographic Map of Los Angeles County, on the scale of 1:24,000 with 5 foot contours, cover part of this district; the West Alpine, Lovejoy Springs, Llano and Black Butte sheets include several striking examples of residual mounts and graded piedmont slopes.

is a granitic arch of impressive dimensions, the finest example of its kind that I have seen. As it has no designation on the Searles Lake sheet of the U. S. Topographic Map, I have named it after the Cuddeback playa to which its southwestern slope drains. On two excursions, first with Mr. Hunt, later with Mr. Storrow, I have had the satisfaction of seeing this arch along both its sides and of crossing over it near the northern end. It is about 20 miles long, northwest-southeast, 2½ miles wide at the 3700-foot contour line, and 4000 feet or more in altitude along its remarkably even crest, or 1500 feet in height above the Cuddeback playa.

From the floor of the playa, the long double curve of ascent to the simple arch crest, 10 miles distant, is an extraordinary, a most impressive sight. Its perfection of smoothness, as seen from that distance, might seem monotonous and uninteresting to a searcher for more striking forms, but to a student of desert degradation it is wholly satisfying. The surface of the arch is, however, interrupted by several rather large residual mounts, as shown in Fig. 23. One near the northern end has a length of 2 or 3

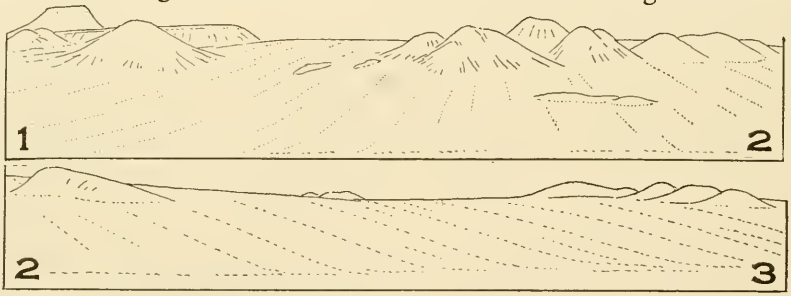

Fig. 23. The Cuddeback Arch, looking east; Pilot Knob in left background.

miles and an altitude of 4615 feet; it is the southernmost of three tabular, basalt-capped masses, which show that a considerable depth of degradation has taken place hereabouts in the production of the Cuddeback Arch, since a previously degraded surface of low relief was buried by the lava sheets and more or less upwarped. Pilot Knob, a famous landmark about 5 miles to the east, gives evidence of still greater degradation; it is capped with earlier volcanic beds on a higher granite floor, which probably marks an earlier surface of degradation than that on which the basalts were outspread.

Another residual rises on the mid-crest of the great arch to an altitude of 4682 feet, or to a height of some 500 feet over the arch; branches from it extend down both slopes. Several hills on the west slope of the arch

near its southern end have altitudes of 3800 or 3900 feet. There can be no question as to the broad convexity of the arch crest, in view of Plate 15, Fig. 2, which shows it as seen from the summit of a transverse road, next south of the steep and talus-covered scarp of the northern basalt table. The eastern side of the arch is less regular than the western: a little to the north of its mid-length a somewhat lower arch, also with a broadly convex crest, branches out eastward and connects with an adjacent range of subdued summits, in which the now vanished "Copper City" was located. Taken as a whole this great arch stands as a willing witness for the process of rock-floor robbing by sheetfloods.

Two Granite Arches near Needles. Two examples of rock floors rising above the feather-edge of their lower detrital covers are described by Lawson from the eastern part of the Mohave Desert, as follows: "This emergence of the bench and its persistence as a subaerial feature appears to be most characteristic of granite ranges which disintegrate into fragments consisting chiefly of the individual mineral constituents, and therefore very uniform in size. The phenomena are exemplified in the group of mountains in southern California west of the Colorado River near the Needles. . . . Here broad alluvial embankments, from six to ten miles across, rise by a gentle slope to the summits of the ranges, where there are residual rock crests or 'nubbins,' and stretches where the crest has entirely vanished as a protuberance above the general slope. Within a mile or more of the summit one passes, without appreciable change of slope, from the alluvial detritus of the embankment on to a bare rock surface extending to the nubbins of the crest. The upper limit of the alluvium is a feather-edge" (37:9-38:3).

This description was not, however, based on Lawson's own observations. A foot note explains that it was supplied by two members of "the geological staff of the Southern Pacific Company," thus suggesting that the delicate difference between a blunt-angled ridge and a round crested arch, which is here under consideration, may not have been critically noted, for the two observers presumably had no such distinction in mind; and suggesting also that, in the absence of specific statement, Lawson's rephrasing of the observers' description as given above was brought into accord with his theoretical views as to the shape that degraded mountain masses should have, just as my expectation of the shape they should have was guided, before I saw either of the divides, by my theoretical views of their origin.

Half-tone plates of both examples are given in Lawson's essay, but

they do not suffice to decide the question at issue. One is described on a fly-leaf opposite its plate as a "divide south of Sunrise Peak, 20 miles southwest of Needles. The upper feather-edge of the alluvial embankment fails to reach the base of the subaerial front, and a bare even rock surface one or two miles wide, having the same angle of declivity as the embankment, extends out from the 'nubbins' at the summit. Beyond this

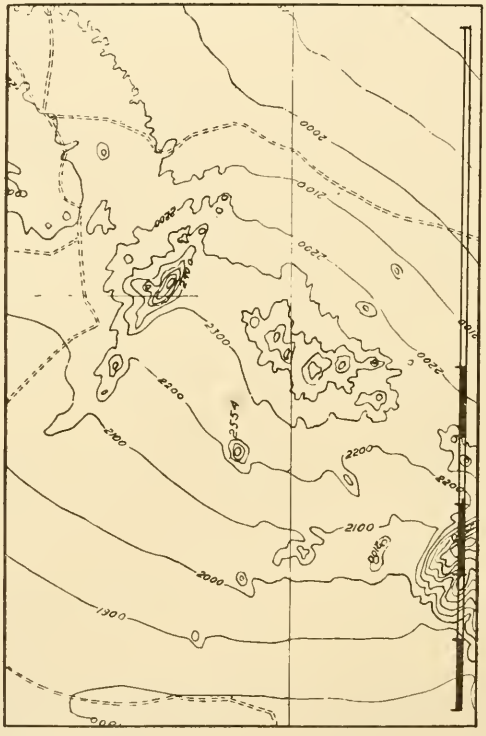

Fig. 24. Divide 20 miles southwest of Needles; from map by Southern California Metropolitan Water District.

the slope has a width of from 6 to 8 miles to the base of the alluvial embankment." The other is "Manchester Divide, near Needles," which is briefly described as having an "alluvial embankment extending up to base of 'nubbins' or residual crest of mountain range. An approximation to the panfan stage of the desert cycle. The subaerial front is small and the suballuvial bench and alluvial embankment both large, the latter being from 8 to 10 miles in width."

The Manchester Divide is included on the Camp Mohave sheet of

the U. S. Topographic Map, but as that sheet, on a scale of 1:250,000 with contour intervals of 250 feet, was published in 1892 from still earlier surveys, the topography is very inadequately represented. The Needles sheet adjoining on the south does not extend far enough to the west to include the other divide; but both are fortunately shown on sheet 68 of the topographic map of recent survey for the Metropolitan Water District of Southern California, on a scale of one inch to 10,000 feet with 100-foot contours, in connection with the construction of the great aqueduct from the Colorado River to Los Angeles. The first, Fig. 24, is at its

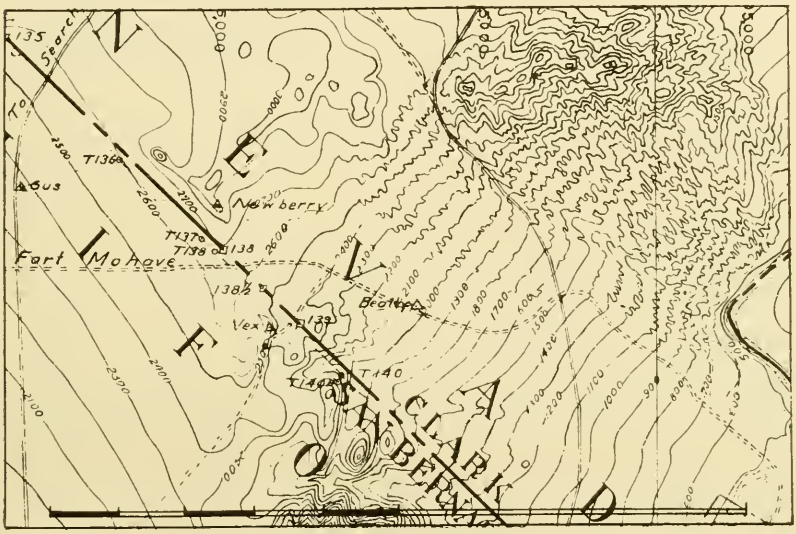

Fig. 25. Manchester divide, 24 miles northwest of Needles; from map by Southern California Metropolitan Water District.

designated distance southwest of Needles; the second, Fig. 25, is 24 miles north-northwest of Needles.

When the attempt was made with Mr. Storrow to reach the first divide, the mapped road leading southward to it from the highway (U. S. 66) along the east side of the Homer-Sablon trough proved to be undiscoverable on the ground and unknown to workmen on the highway who were familiar with other roads thereabouts. So the best that could be done was to take another mapped but execrable road, never graded, rarely used and wholly uncared for, on the west side of the trough, to a point about 10 miles west of our goal. The divide, as then seen across the trough, is outlined in Fig. 26. Its highest summits on the left and right have alti-

tudes of 2800 feet, the lower summits near the middle of the view rise to 2600 feet; the two smooth stretches of the crest are, in the north, between 2300 and 2400 feet, and in the south, between 2200 and 2300 feet. The axial line of the trough west of the divide lies at 1800 feet on the left and at 1700 on the right. Close scrutiny with a good field glass showed an apparent increase in the density of vegetation toward the smooth stretches of the crest, and that I interpreted to mean that the crest is broadly convex. Mr. Storrow's opinion as to the cross profile was: "It would be difficult to know when you reach the summit." I greatly regret our inability to visit this interesting locality.

Fortunately, the Manchester divide, which occupies a space over 5 miles wide in the southernmost angle of Nevada between the Newberry

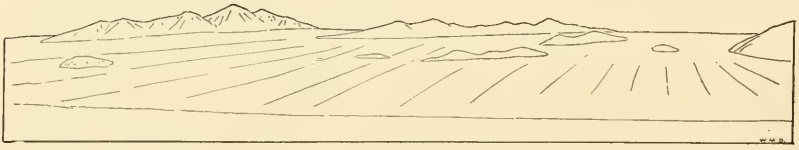

Fig. 26. Divide 20 miles southwest of Needles, looking east.

Mountains on the north and the Dead Mountains on the south, proved to be easily accessible by several rough but practicable roads that lead eastward from the highway which follows up the Piute trough to connect Needles and the Searchlight mining district in Nevada.[13] The altitude of the pass varies from 3000 feet in the north to 2400 feet in the south. Near its middle is a narrow rocky ridge, about a mile long, with knobs 200 or 300 feet high, its southern end being shown in Plate 15, Fig. 3; it is almost coincident with the oblique boundary between California and Nevada. Several smaller ridges and knobs survive near the Dead Mountains. The crest line is bowed to the west, presumably because of faster degradation on the steeper, eastern slope, where a southeastward descent is made at the rate of 300 feet in a mile to a westward curve of the Colorado River, 7 miles distant; while on the gentler western slope a southwestward descent is made into the Piute trough at the rate of 160 feet in a mile. It must be because of the unlikeness of these two slopes that the

[13] One of the cross-roads is of historic interest, as it marks the route followed in the early days between Fort Mohave on the Colorado River and Fort Tejon, 240 miles to the west in Grapevine Canyon in the curved mountain range that limits the Great Valley of California on the south. It ascends by a somewhat winding course from the river, but after crossing the divide it pursues a due west course for 12 miles across the Piute trough to a notch in the lava-capped Piute Range, through which a distant, flat-topped butte, shown in Fig. 8, serves as an excellent landmark.

eastern one now undercuts the western at the crest by 20 or 30 feet, as is shown in some detail for the southern part of the divide in Fig. 27, and in a more general view for the northern half in Fig. 28. It is apparently because of a recent westward shift of the river that much of the eastern slope has been rather sharply dissected by many close-set little valleys, after having been previously more smoothly graded.

As the crest is approached from the western side the slope gradually decreases; and for half a mile before reaching the crest the surface is almost

Fig. 27. Unsymmetrical crest of Manchester divide, southern part, looking northeast.

level, as shown in Plate 15, Fig. 3. When one looks down either slope from a point near the crest, the lower part slowly steepens out of sight: hence there can be no question whatever as to the convexity of the divide. The western surface is slightly dissected near the crest by inbranching valleys, 5 or 10 feet deep, and whatever detrital cover it formerly had is removed. Rock exposures are therefore abundant. Farther west the valleys disappear and the detrital cover is well developed in a mile or so; the re-

Fig. 28. Unsymmetrical crest of Manchester divide, northern part, looking north.

mainder of the descent into the Piute trough is of sheetflood smoothness without rock exposures. The cause of the upper dissection here was not discovered. To the east, the valleys continue according to the map all the way to the river in the northern part of the slope; but in the southern part of the slope no valleys are shown. As far as this slope was examined it now has little detrital cover. The fact that the cross profile of each slope is convex, in spite of the presence of several residual ridges and knobs near its crest, is significant.

Other Desert Arches. During traverses of the desert region several even, intermont skylines were noted, which could not be reached as no road led over them but which appeared to have arched or convex crests, like those above described. One of them, Fig. 29, lies next south of the

Fig. 29. Even crest line in the Piute Mountains, looking west.

lava-capped part of the Piute Range, Fig. 8, between Lanfair and Piute troughs. Another, Fig. 30, lies north of the eastern part of the Sheephole Mountains, toward the Cadiz-Vidal trough. A third lies from 20 to 40 miles northwest of the Cima Dome; it is crossed at a sag by the highway from Los Angeles to Salt Lake City. Various other examples will doubtless be found, and it is expected that their arched crests will be covered only with weathered rock in place.

Desert Granitic Domes on the Sierra Nevada. Before the Sierra Nevada was upfaulted to its present altitude, which in its highest eastern margin amounts to over 10,000 feet, most of its area appears to have belonged to an extensive, submountainous or lowland region of advanced degradation, which I have called, as already intimated, the "Powell sur-

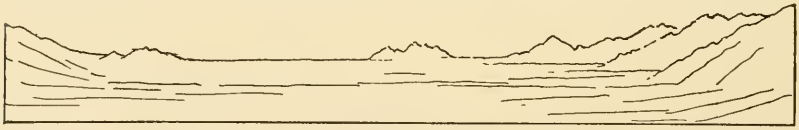

Fig. 30. Even crest line north of Sheephole Mountains, looking east.

face" (1925). The climate of its southern part must then have been much more arid than it is now and its senescent or senile forms may therefore have resembled those seen today in other parts of the same region not yet disturbed; for example, in the Muroc-Llano district of the Mohave Desert, where, as has been told above, something very like what the Powell surface is believed to have been is still to be seen. Hence, in the granitic areas of the Powell surface, more or less completely graded domes should then have been present.

The southern Sierran highlands today exhibit broad plateau-like surfaces, which are presumably the slightly modified lowlands of that earlier area; and these highlands are surmounted by residual summits of

dome-like form, except that great cirques have been excavated in their flanks by Pleistocene glaciers. Lawson was the first to give good account of these mountain forms, just as he was the first to give thorough explanatory treatment to the epigene profiles of the desert; but here as there I wish to modify his explanation. He described the Sierran summits as follows:—"Several of the culminating portions of the summit divide are either flat topped, or have slopes which are so gently inclined as to be in sharp contrast to the more precipitous slopes [of glacial excavation] which abound in the region" (1903, 307). Evidently, therefore, the Sierran domes were better developed in Preglacial times than they are now; but they still rise over "a splendid plateau" (308); that is, over a part of the uplifted desert peneplain now trenched by deep valleys of later erosion. The same observer suggests that the Sierran domes represent granite batholiths, stripped of their former cover; that is, the height which they retained over the surrounding lower land before upheaval of the Sierran block took place, was the result of structural control, independent of gradation with respect to the baselevel of the time. Furthermore, while recognizing that the erosion of the lower land also might have been similarly controlled, he prefers to interpret it as "a broad valley bottom nearly at baselevel" (315).

With this latter explanation I am fully in accord, but for the former an alternative explanation is here offered, in view of the belief that the Sierran highland was, before its upheaval, a somewhat diversified desert lowland. The alternative explanation is that the granitic domes as well as the plateau which they surmount are all parts of a region of advanced arid degradation, now uplifted and much modified by ordinary and by glacial erosion. This view is preferred on several grounds: First, it is reasonably associated with the probable history of the region before the great Sierran block was upheaved. Second, the gradual slopes by which the preserved parts of the domes now descend to the plateau are strongly suggestive of their having been graded with respect to the baselevel of their time, although they were not worn down so completely as the lowland areas were; but it should be understood that the lowlands themselves may have then stood hundreds of feet above baselevel, in view of their situation at a good distance inland from the ocean shore, and in view of the relatively strong gradients of graded desert sheetfloods. But third and more significant still is the fact that the batholithic granites are less resistant to desert weathering than are the schists into which they were intruded; hence, as far as structural control was effective, the residual summits of

that time should not have been granite domes but peaked and steep-margined schists over retreating slopes of the weaker underlying granites. Some such forms appear to occur in the High Sierra of today; but they are exceptional compared to the prevailing granitic domes. The domes of the High Sierra therefore seem best explained as the domes of today are.

The same explanation may, perhaps, apply to the rounded summits of the Front Range of the Rocky Mountains in Colorado, where the uplifted peneplain of the highlands—so first recognized by Powell over 60 years ago—are surmounted by well preserved domes at lesser elevations and by glacially modified domes at greater elevations, as I had opportunity of seeing during a summer field course in 1910 (1911); for before the elevation of that region, its climate must have been significantly drier than now; so much so that, following Blackwelder, we may suppose the Colorado river was then not much larger than its little tributary, the Gila, is today.

Another lesson of importance in the analysis of High Sierran forms may be learned from the desert; namely, the considerable differences of

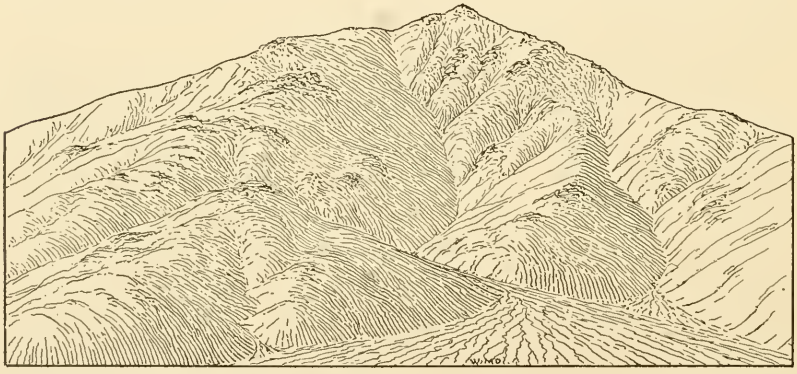

Fig. 31. Fremont Peak, looking west.

altitude between the rock floors and their domes in different parts of a worn-down arid region. For example, the crest of the northern half of the Manchester divide, described above, stands at an altitude of 3000 feet; it is connected by the continuously graded detrital floor of the Piute trough with a relatively narrow, sub-detrital, contemporaneous rock floor marginal to the south end of the Dead Mountains, 20 miles to the south, which stands at an altitude of only 1600 feet. Similarly, the rock floors on the west side of the northern Piute Mountains near the head of Lanfair

trough have an altitude of 3600 feet; while contemporaneous rock floors at the base of the Ship Mountains, where the prolongation of the Lanfair trough joins the Cadiz trough, have an altitude of only 1000 feet. Evidently, therefore, desert rock floors now uplifted in the High Sierra should not be expected to have uniform height.

Examples of Non-Granitic Desert Mountains. Three good illustrations of the irregular degradation of non-granitic mountains may be selected from many others. Fremont Peak, Fig. 31, northwest of Barstow and next south of Cuddeback playa, illustrates the irregular alternation of outcropping ledges and steep-graded slopes which results from the non-homogeneous structure of these masses; also, the deep penetration of a valley into the heart of the mass, and the persistently concave basal slopes, as determined by the disintegration of their rocks into blocks, scraps and

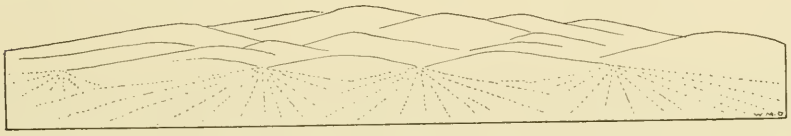

Fig. 32. Group of non-granitic residual mounts, south of Barstow.

grains of all sizes, by which the mountain passes gradually into its detritus-covered rock floor. Tiefort Mountain, next south of the Granite Mountains, like the two Ord Mountains north of the Lucerne trough, is of somewhat more massive form; but otherwise it systematically repeats the features of Fremont Peak with merely individual variations.

The best illustrations of the senescent forms of similar masses that I have seen are crossed by a road between Barstow and Stoddard Well. Quite unlike the granitic residuals which retain their steep faces until, after being reduced to mere heaps of boulders, they vanish, these non-granitic residuals have faint, smoothly graded slopes, Fig. 32, hardly distinguishable from the detrital cover of the rock floor into which they merge imperceptibly; and instead of being reduced to simple domes or arches of large but low-curved convexity, they survive as groups or belts of low mounts at the summit of long detrital slopes, Fig. 5. It would thus appear that it is not only by pattern and color of outcrops that the geological structure of a desert area may be roughly mapped from a commanding point of view, but that even where outcrops are scanty, reconnaissance work may be guided by form, at least to the extent of differentiating areas of granitic from non-granitic rocks.

Mounts of Resistant Rock on Granitic Domes. The occurrence of mounts of more resistant rock on granitic domes is not infrequent. They are often composed of aplite and then presumably represent centers of minor intrusion into the granite. They differ from surviving knobs of granite in having, by reason of their habit of weathering into blocks, scraps and grains, concave basal slopes which grade delicately into the larger detritus-covered granitic area. An excellent example of this kind

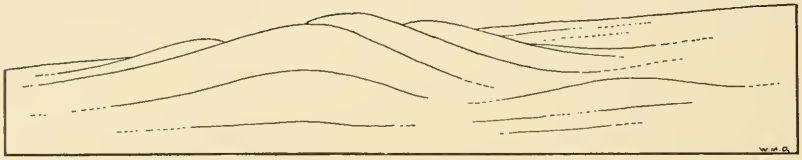

Fig. 33. Subdued aplite mounts, southeast slope of Cima Dome.

may be seen on the southeastern slope of the Cima Dome, Fig. 33; another is found on the lower part of the long bahada which slants southward from the Granite Mountains to Bicycle playa, Fig. 34. In their later stages these residuals are reduced to less and less convexity and eventually become, as Lawson says, "mere patches of bed rock obscured by the residual unmoved products of disintegration, nearly but not quite flush with the general slope" (1915, 32:3). The desert offers various beautiful

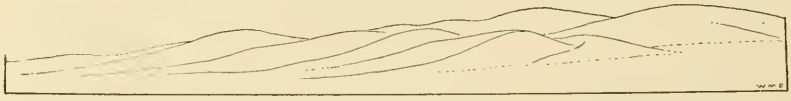

Fig. 34. Subdued non-granitic hills, at southern base of Granite Mountains.

examples of such vanishing mounds. The most delicate one that I have seen is not far east of Stoddard Well on the road that leads toward Ord Mountain, about 8 miles south of Barstow.

Concluding Remarks. It will have been noticed, especially by petrographers if any are included among my readers, that the mountain-making rocks of the desert are here classed simply as granitic and non-granitic. This is because it has been impossible for me to attempt a better classification. It is therefore to be expected that, when a better classification is made, various new details as to mountain forms will be discovered. In the meantime I hope that the distinctions here recognized between the two classes of rocks, by reason of their different habits of disintegrating and their resulting differences of form, may hold good and prove to be of serviceable interest to students of desert landscapes.

Fig. 1. Low-grade domes near High Vista, between Barstow and Lancaster.
(Photo by Hunt)

Fig. 2. Broadly convex crest of the Cuddeback Arch, looking south.
(Photo by Storrow)

Fig. 3. Level crest of Manchester Divide, southern part, looking southeast.
(Photo by Storrow)

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 21, pp. 259-272, plates 16, 17

NOTES ON THE FORAMINIFERA OF THE TYPE MERCED AT SEVEN MILE BEACH, SAN MATEO COUNTY, CALIFORNIA

BY

ROSCOE E. & KATHERINE C. STEWART

Ventura, California

SAN DIEGO, CALIFORNIA

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NOTES ON THE FORAMINIFERA OF THE TYPE MERCED AT SEVEN MILE BEACH, SAN MATEO COUNTY, CALIFORNIA

BY

ROSCOE E. & KATHERINE C. STEWART

Ventura, California

In 1927 the authors collected thirty-four formation samples from the type section of the Merced series for use in the correlation charts of papers then in preparation on the post-Miocene foraminifera of Humboldt[1] and Ventura counties. At the time there was no thought of getting out a separate paper on the foraminifera from these samples, but later study of the material has made it seem advisable to describe a new *Nonionella* which is rather persistent in the section and to record the other species of foraminifera with which it is here found associated. Such a description and record are the purposes of this paper, which is offered in partial fulfillment of the requirements of work taken at the University of Southern California.

The sampled stations were located with respect to a section paced along the coast between Mussel Rock and the Olympic Club salt water pump house, and additional checks were made with respect to topography. The location of the pump house was obtained through the courtesy of Mr. F. J. Foran of the Olympic Club, Mr. I. E. Flaa of the Spring Valley Water Company and Dr. G. D. Hanna of the California Academy of Sciences.

The type section of the Merced series occurs on the San Francisco Peninsula at Seven Mile Beach, about eight miles south of the Golden Gate. From Mussel Rock, where the basal bed rests unconformably upon the Franciscan, the strata are exposed in ascending sequence to Lake Merced, representing a thickness, as measured by Lawson,[2] of 5834 feet.

This series has quite generally been considered upper Pliocene in age; younger than the Purisima, and perhaps equivalent to the upper part of the Wildcat series of Humboldt County. Evidence to be presented by the authors in a later paper supports this correlation with the upper Wild-

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[1] The Humboldt County work will include a paper now in preparation on the megafossils of the Wildcat series, in addition to those on the foraminifera.

[2] Univ. Calif. Publ. Bull. Dept. Geol., vol. 1, p. 146, 1893.

cat, although it is to be borne in mind that the Wildcat may be somewhat older, as suggested by J. P. Smith,[3] the fauna having migrated southward along the coast.

Several authors[4] have discussed evidence for a division of the series into upper and lower Merced, and for a possible Quaternary age of the upper division. Their point of division in the type section is in the vicinity of Thornton. The data obtained from the few samples considered in this paper are hardly complete enough to justify any definite conclusion regarding such a division, but they suggest that a closer sampling of the section might bring out some very interesting evidence in this regard.

It is worthy of note that more species make either their first or last appearances in the section at the horizon represented by samples 18 and 19 than at any other horizon indicated on Plate 16. Of the twenty-three species and varieties of foraminifera listed, eight make their first appearances and eleven their last appearances in these two samples. Only two of the eight go on up into the section and only five of the eleven go on down, however, the remaining six in each case being confined to one or both of these two samples.

Samples 18 and 19 were taken just north of Thornton from a part of the coastal section which some authors[5] believe to be affected by landslide or faulting. Samples 26 and 27 are from megafossil beds which strike nearly parallel with the shore. Samples 24, 28 and 32 are also from megafossil beds.

Lithologically the Merced is characterized chiefly by soft sandstones and sandy shales. There are occasional beds of very fossiliferous dark clayey mud, and both hard and soft shell beds, as well as thin, hard, unfossiliferous gravel beds occur at intervals. The basal bed, which rests upon the Franciscan at Mussel Rock, is composed almost entirely of plant material, including carbonized wood, bark, matted leaves and pine cones, which, as Lawson[6] has pointed out, is probably an old forest soil representing the land surface just prior to the depression which initiated

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[3] Proc. Calif. Acad. Sci., 4th series, vol. 9, p. 144, 1919.

[4] Among the important references in this connection are: Ashley, G. H., Proc. Calif. Acad. Sci., 2nd series, vol. 5, pp. 318, 330-336, 1895. Arnold, Ralph, U. S. Geol. Survey, Professional Paper no. 47, p. 29, 1906. Lawson, A. C., U. S. Geol. Survey, Geol. Atlas of the U. S., San Francisco Folio, no. 193, p. 14, 1914. Martin, Bruce, Univ. Calif. Publ. Bull. Dept. Geol., vol. 9, pp. 224, 228, 229, 1916.

[5] Op. cit.

[6] U. S. Geol. Survey, Fifteenth Annual Report, p. 460, 1893.

the accumulation of the Merced series. Pine cones, leaves and thin lignitic seams occur here and there, and a thin bed of white volcanic ash has been reported from the upper part of the section.

Martin[7] has expressed the belief that the occurrence of a large number of fossil leaves indicates deposition in an estuarine or littoral zone, and Dorf[8] considers the character of the flora suggestive of coastal conditions of deposition at the mouths of streams. J. P. Smith,[9] basing his conclusions upon invertebrate megafaunal evidence, has stated that the temperature of the sea in which the Merced beds were laid down was probably about 50° F., instead of 55° F. as at present. He considers this megafauna more northern in character than that of the underlying Purisima, agreeing more nearly in character with that of the older and more northerly Wildcat formation. M. L. Natland,[10] judging from a study which he is now making of Recent foraminifera from a section dredged between Long Beach, California, and Catalina Island, believes that the microfauna listed in this paper indicates deposition at depths around 100 to 150 feet. The temperatures which he finds at these depths off Long Beach range around 55° to 58° F. The 50° F. temperature is encountered somewhere around 250 or 300 feet. The surface temperature is about 62° F., some 7° F. higher than that prevailing off San Francisco at present and 12° F. higher than that postulated by Smith for Merced time. It may be that temperature rather than depth is the main controlling factor in the distribution of the species of foraminifera found in the Merced. If so, and if Smith's temperature estimate is correct, these species must have been forced to very shallow depths off San Francisco during Merced time to find temperatures even approximating those at which Natland now finds them off Long Beach.

The authors are indebted to Dr. Joseph A. Cushman, Director of the Cushman Laboratory for Foraminiferal Research, Sharon, Massachusetts, for checking the material used in this paper and for identifying some of the species listed. Data on ocean temperatures were obtained through courtesy of Dr. U. S. Grant, IV and Mr. Clinton G. Abbott of the San Diego Society of Natural History, Dr. T. Wayland Vaughan and Dr.

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7 Univ. Calif. Publ. Bull. Dept. Geol., vol. 9, p. 227, 1916.

8 Carnegie Inst. Wash. Publ. No. 412, p. 45, 1930.

9 Proc. Calif. Acad. Sci., 4th series, vol. 9, p. 144, 1919.

10 Oral communication.

Stanley Wilfred Chambers of the Scripps Institution of Oceanography and Mr. M. L. Natland of Long Beach, California.

The contour map of Plate 16 is adapted from a part of the San Mateo Quadrangle of the United States Geological Survey's topographic maps. The locations of the San Andreas Fault and of the northern and southern limits of the Merced series are adapted from Lawson's map in the San Francisco Folio of the United States Geological Survey's Geological Atlas of the United States.

Description of the New Species

Nonionella cushmani R. E. & K. C. Stewart, n. sp.

Plate 17, figures 1a-c

Test subtrochoid, small, strongly oblique in edge view, dorsal side only partially involute, ventral side completely involute; periphery rounded, but not broadly so except in the later chambers of some adult specimens; earlier chambers usually indistinct, later ones distinct, 11 or 12 in the last formed whorl, umbilicus closed by the extended umbilical ends of the last few chambers upon which a small fistulose growth is developed; apertural face nearly flat in side view and with a slightly raised edge; sutures obliquely curved, indistinct in young specimens but becoming more distinct and somewhat depressed between the later chambers of adult specimens; wall calcareous, smooth, finely perforate; aperture narrow and elongate, at the base of the ventral side of the last septal face. Dimensions of holotype: long diameter 0.46 mm., short diameter 0.33 mm., thickness 0.19 mm.

Holotype (Cushman Coll. No. 16408) and paratypes (Stewart Coll. No. 519, Cushman Coll. No. 16409, San Diego Society of Natural History Coll. No. 421, University of Southern California. Coll. No. S. C. M. Mr. 100, University of Chicago, Walker Museum Coll. No. 37398), from sample locality No. 19 of the type Merced at Seven Mile Beach as shown in Plate 16.

The species is named for Dr. Joseph A. Cushman of Sharon, Massachusetts.

It is rather close in some respects to a form referred by Cushman and Kellett[11] to *Nonionella auris* (d'Orbigny). It has no greatly enlarged ventral portion at the umbilical end of the chambers like *N. auris,* how-

[11] Proc. U. S. Nat. Mus., vol. 75, Art. 25, p. 5, pl. 1, figs. 9a-c, pl. 2, figs. 2a-c, 1929.

ever, and the apertural face is nearly flat in side view and has a slightly raised edge, while that of *N. auris* is decidedly convex with no angle. *N. cushmani* in edge view is nearly always oblique, a feature which distinguishes it from most of the other known species of the genus.

In the material studied for this paper, this species occurs only in samples from the lower part of the section, up to and including sample 20.

LIST OF FORAMINIFERA FOUND ASSOCIATED WITH NONIONELLA CUSHMANI

A few references are given for each species wherever possible, but no attempt has been made to make the reference list complete.

Quinqueloculina seminula (Linné)

Serpula seminulum Linnaeus, Syst. Nat., ed. 12, 1767, p. 1264.

Quinqueloculina seminula (Linné), Cushman, Florida State Geol. Survey, Bull. 4, 1930, p. 19, pl. 2, figs. 1, 2.

Lagena acuticosta Reuss

Lagena acuticosta Reuss, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 305, pl. 1, fig. 4.—Cushman, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 5, pl. 1, figs. 1-3; Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, 1927, p. 146.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 57, pl. 3, fig. 10.

Lagena acuticosta Reuss, var.

Plate 17, figure 4

Two specimens of what appears to be a variety of *L. acuticosta* were found in sample 20.

Lagena laevis (Montagu)

Vermiculum laeve Montagu, Test. Brit., 1803, p. 524.

Lagena laevis (Montagu), Cushman, Bull. 104, U. S. Nat. Mus., 1923, p. 29, pl. 5, fig. 3.

Lagena scalariformis (Williamson), var.

Plate 17, figure 5

Entosolenia squamosa (Montagu), var. *scalariformis* Williamson, Rec. Foram. Great Britain, Ray Society, 1858, p. 13, pl. 1, fig. 30.

A single specimen was found in sample 17 which is very close to the form figured by Williamson.

Lagena sp.

Plate 17, figures 2, 3

Two specimens were found, one in sample 19 and one in sample 20, and since they differ somewhat in the number and development of the costae, both are figured.

Nonionella auris (d'Orbigny)

Valvulina auris d'Orbigny, voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 47, pl. 2, figs. 15-17.

Nonionina auris (d'Orbigny), Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, 1926, p. 91, pl. 13, figs. 4a-c.

Nonionella auris (d'Orbigny), Cushman, Florida State Geol. Survey, Bull. 4, 1930, p. 38, pl. 7, figs. 1a-c.

Elphidium hannai Cushman and Grant

Elphidium hannai Cushman and Grant, Trans. San Diego Soc. Nat. Hist., vol. 5, 1927, pp. 77, 78, pl. 8, figs. 1, 2.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 62, pl. 3, figs. 16, 17.

Elphidium hughesi Cushman and Grant, var.

Elphidium hughesi Cushman and Grant, Trans. San Diego Soc. Nat. Hist., vol. 5, 1927, pp. 75, 76, pl. 7, figs. 5a, b.

There appears to be no essential difference between this variety and the form found in the upper part of the coastal section of the Wildcat formation of Humboldt County, California.

Elphidium oregonense Cushman and Grant

Elphidium oregonense Cushman and Grant, Trans. San Diego Soc. Nat. Hist., vol. 5, 1927, p. 79, pl. 8, figs. 3a, b.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 62, pl. 4, figs. 1, 2.

Buliminella elegantissima (d'Orbigny)

Bulimina elegantissima d'Orbigny, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 51, pl. 7, figs. 13, 14.

Buliminella elegantissima (d'Orbigny), Cushman, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 89; Contr. Cushman Lab. Foram. Res., vol. 1, 1925, p. 40, pl. 6, figs. 5a, b.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 64, pl. 4, figs. 7a, b.

Bolivina sp.

A single specimen was found in sample 19 which is too poorly preserved for specific identification.

Eponides ornata (d'Orbigny)

Rosalina ornata d'Orbigny, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 42, pl. 1, figs. 18-20.

Eponides ornata (d'Orbigny), Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 72, pl. 6, figs. 2a-c.

Pulvinulinella pacifica Cushman

Pulvinulinella pacifica Cushman, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, 1927, p. 165, pl. 5, figs. 14, 15.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 73, pl. 6, figs. 5a-c.

Cassidulina cf. **californica** Cushman and Hughes (?)

Cassidulina californica Cushman and Hughes, Contr. Cushman Lab. Foram. Res., vol. 1, 1925, p. 12, pl. 2, fig. 1.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 75, pl. 6, figs. 8a, b.

Only two very small specimens were found which might possibly be referred to this species.

Cassidulina cf. **crassa** d'Orbigny

Cassidulina crassa d'Orbigny, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 56, pl. 7, figs. 18-20.—Cushman, Florida State Geol. Survey, Bull. 4, 1930, p. 58, pl. 11, figs. 6a, b.

A few specimens were found in samples 7 and 13 which seem very close to this species.

Cassidulina cf. **limbata** Cushman and Hughes

Cassidulina limbata Cushman and Hughes, Contr. Cushman Lab. Foram. Res., vol. 1, 1925, p. 12, pl. 2, figs. 2a-c.—Cushman, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, 1927, p. 166, pl. 6, fig. 4.

Only four specimens were found in samples 20 and 28, and all but one of them were broken. The identification is considered questionable.

Globigerina conglomerata Schwager

Globigerina conglomerata Schwager, *Novara*-Expd., Geol. Theil., pt. 2, 1866, p. 255, pl. 7, fig. 113.—Cushman and Wickenden, Proc. U. S. Nat. Mus., vol. 75, Art. 9, 1929, p. 12, pl. 5, figs. 6a-c.

Globigerina cf. **conglomerata** Schwager

A number of specimens were found which appear close to this species but do not show the characters clearly enough to be identified with certainty.

Globigerina sp.

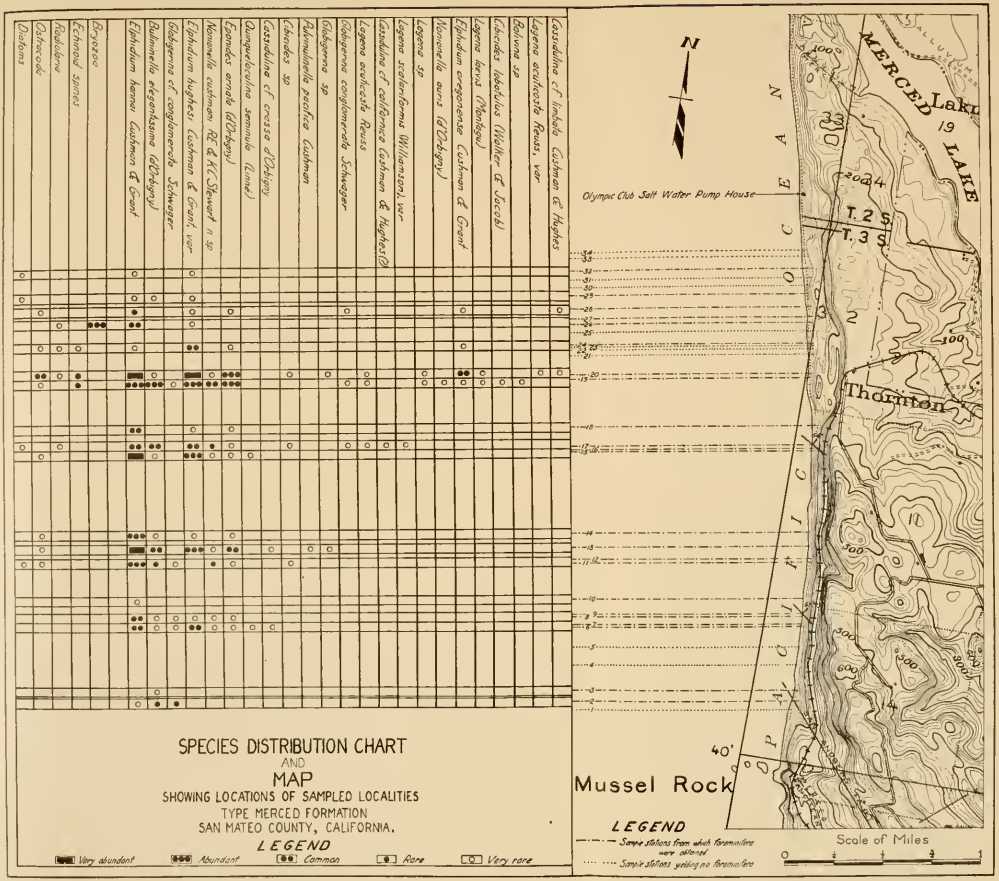
This form is too small and represented by an insufficient number of specimens for specific identification.

Cibicides lobatulus (Walker and Jacob)

Nautilus lobatulus Walker and Jacob, Adam's Essays Micros., Kannmacher's ed., 1798, p. 642, pl. 14, fig. 36.

Cibicides sp.

The specimens of this form are too rare and poorly preserved to justify specific identification.


Diatoms
Radiolaria
Echinoid spines
Bryozoa
Elphidium hannai Cushman & Grant
Bulimina elegantissima (d'Orbigny)
Globigerina cf. conglomerata Schwager
Elphidium hughesi Cushman & Grant, var
Nonionella cushmani RE & KC Stewart n sp
Eponides ornata (d'Orbigny)
Quinqueloculina seminula (Linné)
Cassidulina cf crassa d'Orbigny
Cibicides sp
Pulvinulinella pacifica Cushman
Globigerina sp
Globigerina conglomerata Schwager
Lagena acuticosta Reuss
Cassidulina cf californica Cushman & Hughes (?)
Lagena scalariformis Williamson, var
Lagena sp
Nonionella auris (d'Orbigny)
Elphidium oregonense Cushman & Grant
Lagena laevis (Montagu)
Cibicides lobatulus (Walker & Jacob)
Bolivina sp
Lagena acuticosta Reuss, var
Cassidulina cf limbata Cushman & Hughes
SPECIES DISTRIBUTION CHART
AND
MAP
SHOWING LOCATIONS OF SAMPLED LOCALITIES
TYPE MERCED FORMATION
SAN MATEO COUNTY, CALIFORNIA.
LEGEND
Very abundant
Abundant
Common
Rare
Very rare
N
MERCED LAKE
Lake
Olympic Club Salt Water Pump House
T. 2 S.
T. 3 S.
Thornton
PACIFIC OCEAN
Mussel Rock
40'
LEGEND
Sample stations from which foraminifera were obtained
Sample stations yielding no foraminifera
Scale of Miles
0
1/4
1/2
3/4
1

EXPLANATION OF PLATE 17

PLATE 17

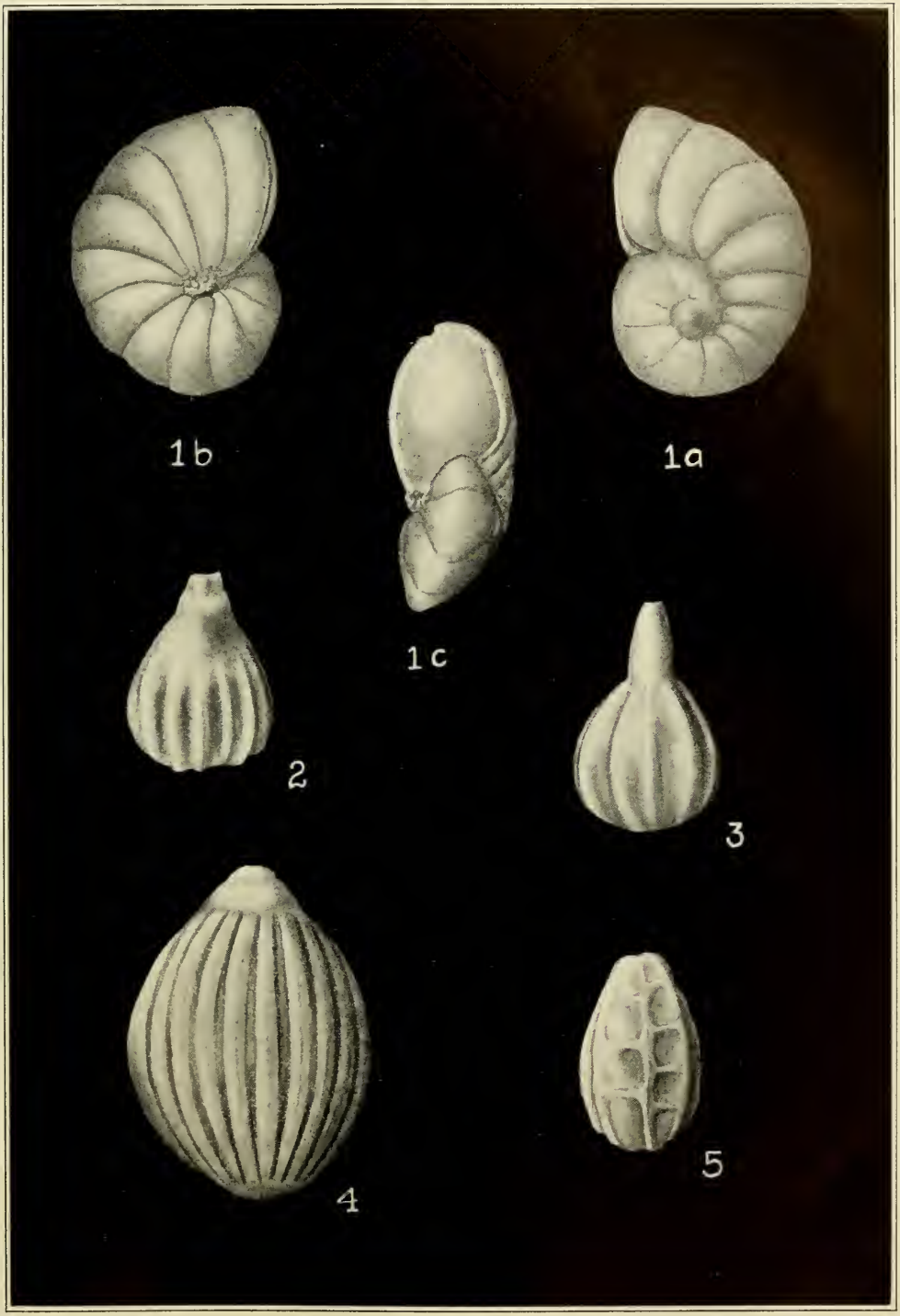
Figs. 1a-c. *Nonionella cushmani* R. E. & K. C. Stewart, n. sp. X 100. a, dorsal view; b, ventral view; c, peripheral view.

Figs. 2, 3. *Lagena* sp. X 90. 2, specimen from sample 20; 3, specimen from sample 19.

Fig. 4. *Lagena acuticosta* Reuss, var. X 90.

Fig. 5. *Lagena scalariformis* Williamson, var. X 130.

(Figures drawn by Miss Margaret S. Moore)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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 22, pp. 273-282, plate 18

A NEW SPECIES OF ECHINOID FROM TAMAULIPAS, MEXICO

BY

MERLE C. ISRAELSKY

Houston, Texas

AND

A NEW GRYPHAEOID OYSTER FROM THE EOCENE OF CALIFORNIA

BY

LEO GEORGE HERTLEIN

California Academy of Sciences

SAN DIEGO, CALIFORNIA

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A NEW SPECIES OF ECHINOID FROM TAMAULIPAS, MEXICO

BY

MERLE C. ISRAELSKY

Houston, Texas

The specimens here described were collected by Mr. Lawrence G. Putnam from 12 kilometers northeast of Abasola, Tamaulipas, Mexico, from beds of upper Eocene age.

Associated with this echinoid were a number of orbitoidal foraminifera which Dr. Joseph A. Cushman determined as *Lepidocyclina* (*Polylepidina*) *adkinsi* Vaughan which was described from upper Eocene of Chiapas, Mexico (Bull. Geol. Soc. Amer., vol. 35, no. 4, Dec. 1924, p. 809).

Oligopygus putnami Israelsky, new species

Plate 18, figures 1, 2, 3, 4

Test tumid, thick walled; outline from above ovoid; ambitus rounded; madreporic system posterior to the center; petals reach about one-half the distance to the ambitus, tending to close distally, interporiferous areas strongly raised; greatest width of petals about one-third length; anterior unpaired petal slightly longer than paired petals, paired petals subequal; viewed from the side the outline is strongly arched above, higher anteriorly than posteriorly, and concave below; the peristome lies in a deep transversely elongate groove slightly behind the center; periproct about two-thirds the distance from peristomal groove to ambitus; surface apparently ornamented with small scrobiculate tubercles.

Syntypes: Nos. 5210, 5211, Mus. Calif. Acad. Sci., collected by Lawrence G. Putnam, 12 kilometers northeast of Abasola, Tamaulipas, Mexico; upper Eocene. *Topotypes*: 5214 and 5215, C. A. S. type collection. *Plasto-Syntypes*: Nos. 422, 423, San Diego Society of Natural History type collection. *Idiotypes*: 424, 425, S. D. S. N. H. type collection.

MEASUREMENTS

	Length	*Width*	*Height*
Syntype No. 5210	23.0 mm.	20.6 mm.	12.6 mm.
Syntype No. 5211	20.6 mm.	18.3 mm.	9.0 mm.

The new species appears to be more closely related to *Oligopygus haldermani* (Conrad)[1] than to any other thus far described. It may be readily distinguished from that form by its more anterior periproct. The posterior position of the madreporic system appears to separate it from other species of the genus.

The species may be the one found by Böse and Cavins[2] in this same district, but not named by them.

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[1] CLARK & TWITCHELL, Mesozoic and Cenozoic Echinodermata of the U. S., Mon. 54, U. S. Geol. Surv., 1915, p. 167, pl. 78, figs. 4a-4d, 5a-5d.

[2] BÖSE & CAVINS, Cretaceous and Tertiary of Southern Texas and Northern Mexico, Univ. Tex. Bull. 2748, 1927.

A NEW GRYPHAEOID OYSTER FROM THE EOCENE OF CALIFORNIA

BY

LEO GEORGE HERTLEIN

California Academy of Sciences

Ostrea haleyi Hertlein, new species

Plate 18, figures 5 and 6

Shell elongate, rounded umbos, broader toward the base; beak curved inward and backward; a shallow groove extends from near the beaks to the ventral margin of the shell where it is more pronounced; a well-defined ligament pit is present beneath the beak. Altitude 45.5 mm.; approximate longitude (shell not complete) 32.5 mm.

Holotype: No. 5526, C. A. S. type coll., from Santa Cruz Island, California; Carl St. John Bremner collector; Domengine, middle Eocene. *Plasto-Holotype*: No. 426, San Diego Society of Natural History type collection. *Paratype*: 427, S. D. S. N. H. type collection.

This species is named for Dr. George Haley, Professor of Biology at the University of San Francisco.

The species is also known from the Eocene of Simi Valley, California. It is placed in the genus *Ostrea* rather than *Gryphaea* owing to the wide variation within the genus *Ostrea*. Trueman[1] has pointed out that forms resembling *Gryphaea* apparently spring from various species of *Ostrea*, entirely independent of other species of similar form.

Several authors[2] have indicated that many forms referred to *Gryphaea*, possess a grypheate character due to the small size of the attached surface.

Gryphaea angulata Lamarck[3] has been cited by Children[4] and many

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[1] TRUEMAN, A. E., Geol. Mag., vol. 59, no. 696, 1922, p. 264.

[2] JACKSON, R. T., Mem. Boston Soc. Nat. Hist., vol. 4, 1890, p. 317; DOUVILLE, H., Bull. Soc. Géol. France, Ser. 4, vol. 10, 1910, pp. 635-642; JAWORSKI, E., Zeitschr. f. Induktiv. Abstamm. und Vererbungslehre, Bd. 9, Heft 3, 1913, p. 201; WOOD, H., Palaeontogr. Soc. London, vol. 66, 1913, p. 341.

[3] *Gryphaea angulata* Lamarck, Anim. s. Vert., 1801, p. 398 [*Nomen nudum*]. Anim. s. Vert., vol. 6, 1819, p. 198. "Habite . . . . "; Chenu, Manual Conchyl., vol. 2, 1862, p. 128, figs. 1009, 1012. *Ostrea* (*Gryphaea*) *angulata* Lamarck, Tryon, Struct. & Syst., Conch., vol. 3, 1884, p. 298, pl. 132, fig. 4.

[4] CHILDREN, J. G., Quart. Jour. Sci. Lit. & Arts, vol. 15, 1823, p. 43.

later writers as the type of the genus, but as pointed out by Dall[5] in his excellent review of this question, *G. angulata* in the original list is given merely by name but is not described or figured. This species cannot therefore be considered as the type. *G. depressa* and *G. angustata* in the original list are likewise undescribed and unaccompanied by any references. Six species in the original list are accompanied by references to figures and have been considered to date from 1801. These are *G. suborbiculata, G. cymbula, G. arcuata, G. africana, G. carinata, G. latissima.* Chenu[6] in 1858 cited *G. arcuata* Lamarck as the type of *Gryphaea* and this can be accepted unless an earlier valid citation is found. If this is accepted then *Liogryphaea* Fischer[7] founded on the same species becomes an absolute synonym as stated by Marwick.

Finlay[8] has given the name *Notostrea* to the New Zealand species, *Ostrea subdentata* Hutton[9] and this nomenclature has been followed by Marwick who referred *Gryphaea tarda* Hutton[10] to *Notostrea.* This New Zealand species resembles *O. haleyi* but it appears to have a somewhat thicker shell and the umbos do not seem to curve so far forward.

Some of the shells figured as *O. musashiana* Yokoyama[11] show a tendency toward a gryphaeoid form.

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[5] Dall, W. H., Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, 1898, pp. 672-675.

[6] Chenu, J. C., Encycl. d'Hist. Nat., vol. 19, 1858, p. 198, "type, G. arquée (*G. arcuata* Lam.)."

For figures and a discussion of *G. arcuata* Lamarck, see Schäfle, Geol. und Palaeont. Abhandl., N. F., Bd. 17, Heft 2, 1929, pp. 26-37, Taf. 2, figs. 7-17; Taf. 3, figs. 1-4 and 9.

[7] Fischer, P., Manuel de Conchyl. 1886, p. 927, type by monotypy, "(*G. arcuata* Lamarck. Lias)," figs. 691 a, b.

[8] Finlay, H. J., in Marwick, J., Trans. N. Z. Inst., vol. 58, 1928, p. 432, "for *Ostrea subdentata* Hutton."

[9] *Ostrea subdentata* Hutton, Catalog. Tert. Moll., 1873, p. 34. "Broken River (L)." Suter, H., N. Z. Geol. Survey, Palaeo. Bull. 2, 1914, p. 46, pl. 17, figs. 9 a, b. "Broken River, South Island. Miocene."

[10] *Gryphaea tarda* Hutton, Catalog. Tert. Moll., 1873, p. 35. "Chatham Islands." ? Tate, Trans. & Proc. & Rept. Roy. Soc. South Australia, vol. 8, 1886, p. 98, pl. 6, figs. 2a, 2b. Australia; Tertiary.

Suter, H., N. Z. Geol. Survey, Palaeo. Bull. 2, 1914, p. 47, pl. 13, figs. 1a, 1b. "Chatham Islands. Miocene." Marwick, J., Trans. N. Z. Inst., vol. 58, 1927 [1928], p. 462-463, figs. 86-96.

[11] *Ostrea musashiana* Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, vol. 39, art. 6, 1920, p. 163, pl. 16, figs. 1-5. Koshiba and Yokosuka; upper Musashino, Pliocene; Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, vol. 44, art. 1, 1922, p. 185, pl. 15, fig. 5, "Shito," lower Musashino, Pliocene.

Ostrea idriaensis Gabb[12] from the Eocene of California has the beaks only slightly curved and is a broader form.

A form figured as *O. idriaensis* Gabb, by Marcus A. Hanna[13] appears to have somewhat twisted beaks but the shell is more rounded than the present form. Hanna's figure somewhat resembles *Pycnodonta brongniarti* Bronn, as figured by Sacco.[14]

Ostrea oregonensis Packard,[15] from the Eocene of southern Oregon, resembles an *Exogyra* somewhat in form but the hinge indicates that it can be referred to *Ostrea;* some of the specimens also resemble *Ostrea* in form.

Ostrea cymbiola Deshayes[16] and *O. profunda* Deshayes[17] from the Eocene of the Paris Basin are similar in shape to *Gryphaea;* the first was referred to the subgenus *Pycnodonta*[18] by Cossmann and Pissarro.

The form of *Ostrea thirsae* Gabb, figured by Heilprin,[19] shows a tendency toward the *Gryphaea* form. Heilprin also gave a figure of *Ostrea* (*Gryphaeostrea*) *subeversa* Conrad which is the type of *Gryphaeostrea* Conrad.[20]

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12 GABB, W. M., Geol. Survey Calif., Palaeo. vol. 2, 1869, p. 203, pl. 33, figs. 103 b, c, d; pl. 34, figs. 103, 103a; "about two miles east of the Hacienda at New Idria, where it is very abundant."

13 HANNA, M. A., Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 16, no. 8, 1927, p. 276, pl. 31, figs. 3 and 4, from U. C. locality 5057; "at the base of the cliff, 100 feet north of the point, which is just west of the north end of the bridge over San Dieguito River. The point forms the north side of the mouth of San Dieguito Valley."

14 SACCO, F., I. Moll. Terr. Terz. Piemonte e Liguria, Pt. 23, 1897, p. 21, pl. 7, figs. 1a, 2a, 2b. "*Tongriano*: Dego, Carcare, Grognardo, Sassello, Cassinelle (frequente)."

15 PACKARD, E. L., Univ. Oregon Publ., vol. 2, no. 4, 1923, pp. 1-15, pls. 1-4. "At bend in Umpqua River about ¼ mile above Glide, Oregon."

16 Figured in Icon. Coq. foss. de l'Eocène des Environs de Paris, vol. 1, 1904-1906, pl. 42, fig. 135-1. "Le Fayel." Bartonien, Eocene.

17 Ibid., pl. 42, fig. 135-5. "Chaumont." Lutetien, Eocene.

18 The type of *Pycnodonta* Fischer de Waldheim, is *Gryphaea vesicularis* Lamarck. Figured in Handbuch Der Palaeontologie, Abt. 1, Bd. 2, 1881-1885, p. 20, fig. 14. "Weisse Kreide. Rügen." See also WOODS, H., Palaeontograph. Soc. London, vol. 66, 1913, p. 360, pl. 55, figs. 4-9. Text figures 143-182.

19 HEILPRIN, A., Ann. Rept. U. S. Geol. Survey for 1882-1883 [1884], p. 311, pl. 63, figs. 4, 5, 6. Eocene.

20 CONRAD, T. A., Amer. Jour. Conch., vol. 1, 1865, p. 15; DALL, W. H., Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, 1898, p. 681.

PLATE 18

Fig. 1. *Oligopygus putnami* Israelsky, n. sp.; length of specimen 20.6 mm. Syntype No. 5211 (C. A. S. type collection), from 12 kilometers northeast of Abasola, Tamaulipas, Mexico; upper Eocene.

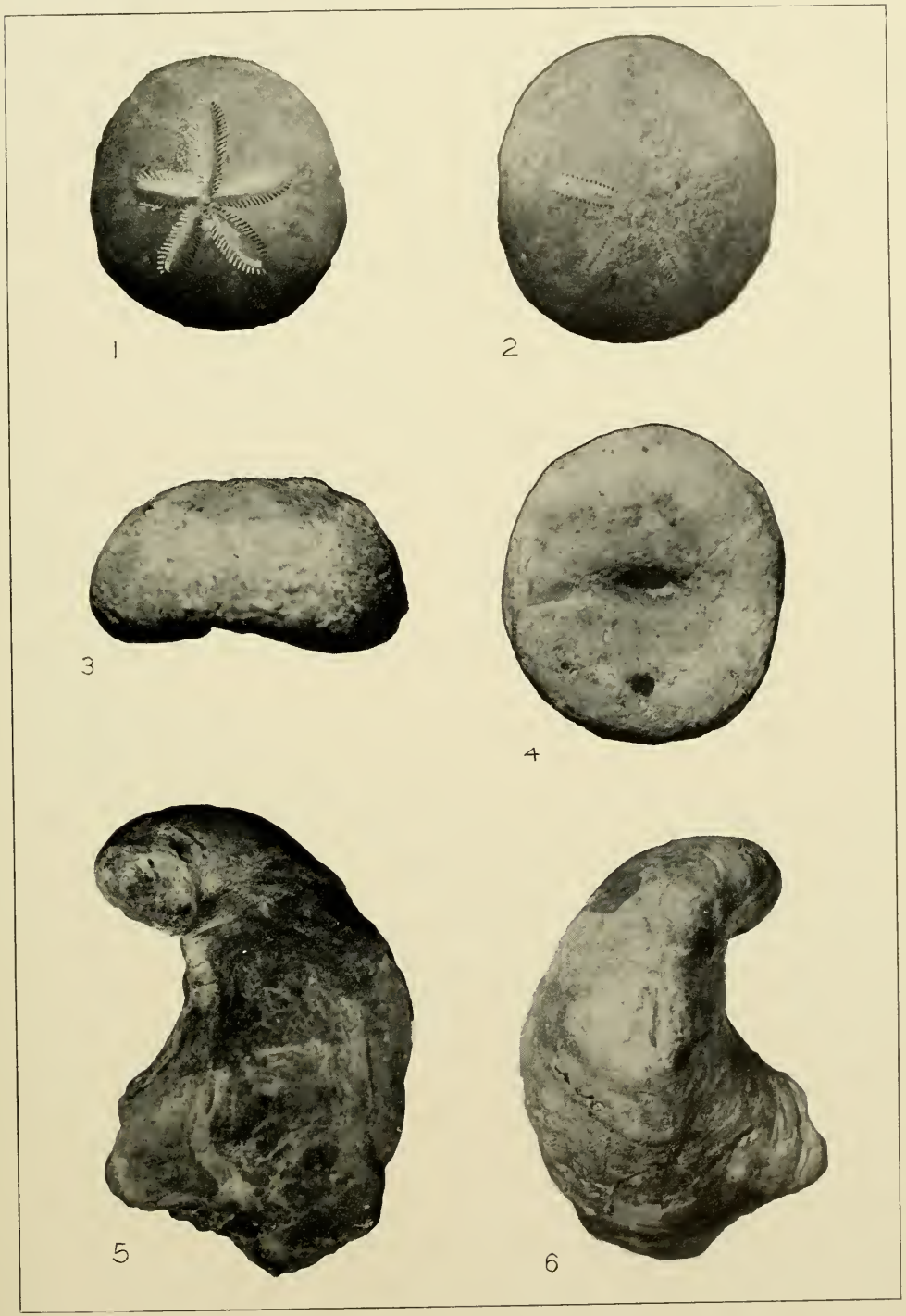
Fig. 2. *Oligopygus putnami* Israelsky, n. sp.; length of specimen 23 mm. Syntype No. 5210 (C. A. S. type collection), from 12 kilometers northeast of Abasola, Tamaulipas, Mexico; upper Eocene.

Fig. 3. *Oligopygus putnami* Israelsky, n. sp.; same specimen as figure 2.

Fig. 4. *Oligopygus putnami* Israelsky, n. sp.; same specimen as figure 2.

Fig. 5. *Ostrea haleyi* Hertlein, n. sp.; lower valve, altitude of specimen 45.5 mm. Holotype, No. 5526 (C. A. S. type collection), from Cañada del Pozo, Santa Cruz Island; Domengine formation, middle Eocene. (Bremner's Loc. 12).

Fig. 6. Same specimen as figure 5, showing interior of valve.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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VII, No. 23, pp. 283-284 MARCH 31, 1933

A NORTHERN RACE OF MELOZONE RUBRICATUM (CABANIS)

BY

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California Institute of Technology

Pronounced differences between a specimen of *Melozone rubricatum xantusii* from Nayarit in the Dickey collection at the California Institute of Technology, and an example of the same species from extreme north-eastern Sinaloa in the collection of the Los Angeles Museum, prompted the assembling of more material in order to determine whether the northern bird represented a geographic race or was merely an aberrant individual. Mr. Ridgway[1] also suspected the existence of a northern race but was unable to make direct comparison between specimens from different parts of the range. Therefore, he could do no more than indicate the probabilities. Thanks to the authorities of the Bureau of Biological Survey, the Los Angeles Museum and the Museum of Comparative Zoology, I have been able to compare 12 skins of *xantusii* from Jalisco, Nayarit, Durango and southern Sinaloa with 22 from northern Sinaloa and south-eastern Sonora. As previously suspected, the northern birds belong to an undescribed race, a pallid form which is apparently confined to the Alamos Faunal District. This may be known as

Melozone rubricatum grisior subs. nov.

NORTHERN GROUND SPARROW

Type.—Male (presumably adult); no. 222,695, collection of Museum of

[1] Birds of No. and Mid. Amer., 1, 1901, 441, footnote.

Comparative Zoology; Hacienda de San Rafael,[2] "Chihuahua" [i. e. Sonora]; May 11, 1888; collected by M. Abbott Frazar.

Subspecific characters.—Similar to *Melozone rubricatum xantusii* (Lawrence) but coloration everywhere paler and grayer; back, wings, tail, flanks and forehead, deep grayish olive instead of olive brown or deep olive; red of hindneck and face cinnamon rufous or tawny instead of Sanford's brown or hazel; under tail coverts between cinnamon and cinnamon buff instead of ochraceous tawny; bill very slightly shorter, averaging 14.0 instead of 15.1 mm.

Range.—Extreme south-eastern Sonora (Hacienda de San Rafael), north-eastern Sinaloa (Questa del Tigre) and probably contiguous portions of Chihuahua.

Remarks.—This new sparrow parallels, in pallor of coloration, the trend usual to the Alamos District races which represent northern extensions of southern species.

Many, nearly half, of the San Rafael birds have more or less pronounced dusky streaks on the breast and flanks, a condition which is not dependent on sex nor, so far as I am able to judge, on age. None of the 12 *xantusii*, even those which are obviously immature, show this condition and I am unable to account for it other than as an incipient racial character. However, since only about half of the specimens are so marked, the character, if it be such, has been ignored in the diagnosis.

Nelson[3] is probably correct in suggesting that Bonaparte's *Pyrgisoma kieneri* is identical with *xantusii*. The variations in *xantusii*, both as to size and the distribution of red on the head, are pronounced and occasional examples, notably, 156099, Biological Survey collection, from San Blas, Nayarit, and 164368 of the same collection from Chacala, Durango, approach *kieneri*[4] in several details of head coloration. However, until the type of *kieneri* can be examined by someone familiar with the problem there is no occasion to change the names in current use for the three known races of this species.

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[2] For the exact locations of Hacienda de San Rafael and other localities in which Frazar collected, see Griscom, Auk, Jan., 1933, pp. 54-58.

[3] Auk, 15, Apr., 1898, 156.

[4] As pictured by Sclater and Salvin, Exotic Orn., 9, 1868, pl. 65.

28 898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VII, No. 24, pp. 285-286 OCTOBER 6, 1933

A NEW SOLITARY VIREO FROM CENTRAL AMERICA

BY

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Dr. Josselyn Van Tyne's recent discovery[1] that a resident race of the Solitary Vireo (*Vireo solitarius notius*) inhabits the pine regions of British Honduras, led to a reexamination of two somewhat anomalous specimens collected in El Salvador. These I had tentatively called *Vireo solitarius cassinii* in spite of the fact that one of them was in breeding condition and in full song when taken. The only other Central American specimen of the *cassinii* type of coloration known to me is one collected by A. W. Anthony at Finca La Primavera, near Coban, Guatemala and recorded as that form by Mr. Ludlow Griscom[2]. Through the courtesy of the American Museum of Natural History, I have been able to compare this bird with the two from El Salvador and find all three to be virtually identical. They are certainly not *cassinii,* nor are they *notius,* three specimens of which have kindly been forwarded by Dr. Van Tyne, but represent an unnamed race inhabiting the lower highlands from central Guatemala south to El Salvador. This race is described as

Vireo solitarius montanus subs. nov.

Type.—Male adult, in breeding condition; no. 18,901, Dickey collection

1 Occasional papers of the Museum of Zoology, University of Michigan, No. 256, Feb. 10, 1933, pp. 1 and 2.

2 Distribution of Bird-Life in Guatemala, Bull. Am. Mus. Nat. Hist., 64, 1932, p. 318.

at the California Institute of Technology; Hacienda Chilata, Depto. Sonsonate, El Salvador, April 23, 1927; altitude 2000 feet; collected by A. J. van Rossem, original no. 11,769.

Subspecific characters.—Nearest to *Vireo solitarius notius* Van Tyne of British Honduras, but size decidedly larger and underparts more heavily overlaid with dusky olive green. Differs from *Vireo solitarius cassinii* Xantus of western North America in slightly darker and more leaden upper parts, darker and more greenish underparts, lateral tail feathers with decidedly more of white on both outer and inner webs, much longer tenth (outer) primary, and more rounded wing, in which the fifth primary is longer than the ninth.

Range.—Mountains of Guatemala (Finca La Primavera, alt. 3200 feet) and El Salvador (San José del Sacare, 3600 feet; Hacienda Chilata, 2000 feet).

Remarks.—The two Central American races, *notius* and *montanus*, are alike in possessing the long outer primary and rounded wing, both of which characters run counter to the old concept of the subgenus *Lanivireo*. However, they are not alone in this respect for every example in the series of *Vireo solitarius lucasanus* not only has the fifth primary longer than the ninth, but also has the tenth primary developed far beyond the degree seen in *solitarius, cassinii* and *plumbeus*. The gradual transition from the "*Lanivireo*" to the "*Vireo*" type of wing may be seen in the accompanying table.

Finca La Primavera is described[3] as in a country of "pine, oak and alder with rain forest along the ridges." The San José del Sacare specimen was taken in a pure pine-oak association, while the type from Hacienda Chilata was collected in a balsam forest (*Toluifera*) with coffee undergrowth. This last named locality is supposed at one time to have supported a considerable growth of oaks, though the only evidence of such cover which I personally found was an occasional small patch of saplings. The normal range of *montanus* is very probably the pine-oak association of the Arid Upper Tropical Zone.

Specimens examined.—Extensive series of *solitarius, cassinii* and *plumbeus;* 13 *lucasanus* (Museum of Vertebrate Zoology); 3 *notius* (University of Michigan); 3 *montanus* (1 from American Museum of Natural History).

Average measurements in millimeters.—

	Wing	*Outer Primary*	*Tail*
10 *cassinii*	72.5	11.1	52.3
7 *lucasanus*	67.6	14.6	51.1
3 *notius*	64.3	15.3	49.3
3 *montanus*	68.6	17.6	52.2

[3] Distribution of Bird-Life in Guatemala, Bull. Am. Mus. Nat. Hist., 64, 1932, p. 418.

28 890

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 25, pp. 287-298, text figs. 1, 2

THE CANADA JAYS OF NORTHERN IDAHO

BY

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SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

OCTOBER 6, 1933

COMMITTEE ON PUBLICATION

U. S. GRANT, IV, *Chairman*

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THE CANADA JAYS OF NORTHERN IDAHO

BY

ALDEN H. MILLER

University of California

The Rocky Mountain Jay, *Perisoreus canadensis capitalis,* since its description in 1873, apparently has been regarded by all systematists as a well differentiated race of *Perisoreus canadensis.* The easily recognized feature of restricted black on the head is the principal character that has been used to separate this form from *P. c. canadensis.* The restriction of the black area to the occiput leaves the eye entirely surrounded by white or pallid neutral gray, whereas in *P. c. canadensis* the slate-black of the crown and occiput reaches the orbit posterodorsally and forms a dark eye ring (names of colors based on Ridgway, Color Standards and Color Nomenclature, 1912). Another important character of *capitalis* is the light mouse gray of the back (between light mouse and mouse gray in the posterior portions but approaching pale smoke gray anteriorly) in contrast to the deep neutral gray of *P. c. canadensis.* Lighter pigmentation in the Rocky Mountain form is also seen on the breast, in the blackish slate of the occiput, and even to a slight extent in the rectrices and remiges. *Capitalis* further is characterized by large size, the average difference in wing length, for example, between it and *P. c. canadensis* being over 7 per cent.

The characters of *capitalis* as here reviewed, namely, head markings, pigmentation and size, are fully correlated in populations from Colorado and Utah, that is, all individuals exhibit all three general characteristics, each character varying among individuals only within relatively narrow limits. Through the kindness of Dr. Angus M. Woodbury of the University of Utah, I have had the use of seven birds from the Uinta Mountains, Utah, all taken in September or October, either in 1931 or 1932. These specimens serve well to indicate the nature of the population from which the type of *capitalis* was taken, in that they are in fresh plumage and have not had opportunity to fade since the time they were collected. There are few birds that, for comparative purposes, necessitate the use of fresh plumages, freshly collected, more than do members of the genus *Perisoreus.* It should be recalled that the type of *capitalis* was collected on Henry's Fork, southwestern corner of Sweetwater County, Wyoming, on the north

slope of the Uinta Mountains. In addition to the examples from these mountains, there are at hand eight more from Utah and Colorado, four of which are in fresh plumage.

The nature of the transition from true *capitalis* to *P. c. canadensis* to the northward should be of considerable interest since the magnitude of the differentiae is relatively great for a subspecific separation. It has generally been considered (see Ridgway, Birds, N. and M. Am., 3, 1904, p. 371, and Brooks and Swarth, Pacific Coast Avifauna, 17, 1925, pp. 79-80) that *capitalis* extends into southern British Columbia as far as Field and accordingly through the mountains drained by the Kootenay and Columbia rivers. A different concept of *capitalis* must have led Austin (Memoirs Nuttall Ornith. Club, No. VII, 1932, p. 159) to consider that it ranged to northern British Columbia. Somewhere between Field and the Cariboo area to the north, the characters of *P. c. canadensis* appear in full force. I have had available birds taken by T. T. McCabe and E. B. McCabe in the Barkerville region of the Cariboo district. These are in all characteristics *P. c. canadensis*. The eye in all eleven of the series is entirely surrounded by slate-black and they are of as small size as *P. c. canadensis* (see table of measurements). Fourteen additional specimens taken west of the Cariboo district but at the same latitude are identical with the eleven from near Barkerville. Oberholser has arbitrarily fixed the type locality of *P. c. canadensis* as the city of Quebec on the probability that the original specimens were taken near that place (Proc. Biol. Soc. Wash., 27, 1914, p. 49). The original locality designation was merely "Canada." I have assumed that a series from northern Minnesota, recently collected, is representative of this race that extends transcontinentally through the forests of Canada. I am unable to make any clearly defined distinctions in coloration of the back or underparts between birds of comparable, unworn plumage from the Barkerville region, Minnesota and northern British Columbia (Atlin and Stikine River). If anything, the Barkerville birds are darker and more neutral in hue on the breast and back, and are slightly smaller than the northern British Columbia and Minnesota series. The differences in color and size, however, are variable individually and so slight that I doubt the advisability of attaching much significance to them. My point in mentioning them is that if the Barkerville series is different, even though only to slight degree, the difference is not in the direction of the true, light-colored and large-sized *capitalis*.

In the summer of 1932 Mr. Robert T. Orr, Mr. Dean H. Blanchard and I collected several *Perisoreus canadensis* in northern Idaho, five near

Meadow Creek, Boundary County, and two others at Weippe, Clearwater County, 160 miles in an airline to the south. These birds taken in July show enough of the new body plumage, particularly on the back, to indicate that they are unlike true *capitalis*. More material from Idaho has been assembled, particularly a series of ten skins taken in September and October of 1928 by Charles F. Hedges at, or near, Priest Lake, Bonner County. These have been loaned through the courtesy of Mr. Ralph Ellis. Analysis of all northern Idaho specimens shows that the transition from *capitalis* to *P. c. canadensis* can not involve a simultaneous change of all characters of color, head markings and size in British Columbia. In Idaho the birds are as darkly colored as the Barkerville birds and as small as *P. c. canadensis*. But, the *extent* of the black on the head is that of *capitalis*. Apparently it is the latter characteristic that has been responsible for previous identification of northern Idaho specimens as *capitalis*.

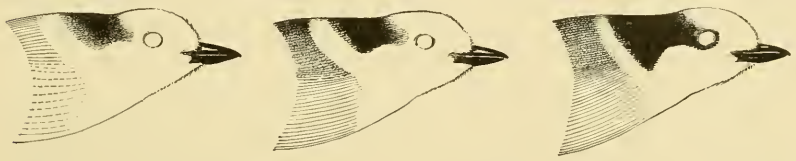

Fig. 1. Heads of Canada Jays from three geographic areas: left, Utah; center, northern Idaho; right, central British Columbia. One-third natural size. Shading approximates, in so far as possible, the different intensities of gray.

The Idaho representation is entirely uniform, all birds being the same dark color, yet with the white or pallid neutral gray of the head extending back to and surrounding the eye completely. The result is a bird of striking contrasts in plumage. As already indicated, south of the Cariboo district in southern British Columbia jays of this group take on the head markings of *P. c. canadensis,* but it is equally clear that in northern Idaho full resemblance to *P. c. canadensis* in dark coloration and small size has been reached. From farther south in Idaho I have only worn plumages to compare, but birds from Adams County are almost as small and, though extremely worn, appear very much darker than comparably worn *capitalis* from Utah. Apparently the transition in color and size takes place along the mountain chain extending to the east of Adams County in the direction of Yellowstone Park, although it is possible that birds from the latter region may not be typical of *capitalis*.

Measurements of male *Perisoreus canadensis* in millimeters

Region	*Number*	*Wing*	*Bill*	*Tarsus*
Northern Minnesota	7	144.0 (141.5-146.4)	14.6 (14.0-15.3)	35.1 (33.6-36.6)
Northern B. C., Atlin and Stikine River	14	144.7 (140.5-148.0)	15.1 (*9 spec.*) (14.1-16.5)	34.9 (32.2-37.1)
Central B. C., latitude of Barkerville	12	143.2 (137.0-148.5)	13.8 (12.8-14.6)	34.2 (33.3-35.7)
Northern Idaho, Bonner and Boundary Cos.	9	143.1 (138.8-147.3)	14.4 (13.5-15.1)	34.2 (33.4-35.3)
Central Idaho, Adams Co.	5	146.2 (144.8-148.0)	15.0 (*4 spec.*) (14.4-15.5)	34.1 (33.6-34.7)
Utah and Colorado	7	155.4 (152.8-159.0)	15.7 (15.2-16.3)	36.3 (35.3-37.3)

Numbers outside of parentheses indicate averages; those within parentheses are the extremes. Where the number of measurements taken is other than that indicated in the number column, it is indicated in italics. Bill measurement is taken from nostril to tip; tail measurements are omitted because of the small number available and because of extreme individual variation.

The transition from the *capitalis* type northward through Montana to Alberta is probably of an entirely different sort, for the end result in the Red Deer district of Alberta according to Peters (Proc. New England Zool. Club, VII, 1920, p. 51) is not *P. c. canadensis* but *P. c. albescens,* an extremely pale bird (paler than *capitalis*) yet possessed of the head markings of *P. c. canadensis.* I have no material with which to extend appreciably our knowledge of the situation in this area, but wish to stress that the trend of geographic variation from *capitalis* to *canadensis* east of the Rocky Mountains in Alberta is apparently an entirely different one from that in Idaho and southern British Columbia. A single bird from seventy-five miles north of Dunvegan on the Peace River, Alberta, bears close resemblance to *albescens.* The head markings are as in *P. c. canadensis* and the coloration as in *capitalis.* It is, however, no lighter than *capitalis* and so may indicate the northern margin of the *albescens* type of bird. Two specimens from the lower Athabasca River, northern Alberta, taken in September are typical of *P. c. canadensis* (see map, fig. 2).

The facts outlined so far, indicating the mode of transition from *capitalis* to *P. c. canadensis,* are the important ones. In summary, all characters involved do not intergrade at the same point, but do so in at least two groups at widely separated points. The intergradation in any one character appears not to be an extremely gradual one, such as a gradient

in color or size extending the length of the Rockies from Utah to Canada. It is regretted that the details of the intergradation can not be more fully elaborated at this time.

Of distinctly lesser importance in the mind of the author is the question of taxonomic treatment that should be accorded the Canada Jay populations of northern Idaho. It is clear from their nature that the names *capitalis* and *P. c. canadensis* are not appropriate. *P. c. albescens* of Alberta, even though described from old skins taken in the spring season, must be a relatively light-colored bird and so have nothing to do with the very dark Idaho birds. Neither do the Idaho jays show any approach to the coastal jays, *P. obscurus obscurus* and *P. o. griseus*. We can not properly call them intergrades since in no one character are they truly intermediate. Furthermore, they are stable in their characters over northern Idaho and southeastern British Columbia, and apparently are similar in eastern Oregon. Since the characters are those of the adjacent forms of the species, these birds are in a sense annectent. But, they are not a group of hybrids, for the individuals are all the same and the hypothetical parent types (*capitalis* and *P. c. canadensis*) do not coexist geographically. The situation is very different from groups of hybrid flickers or from hybrid juncos such as *Junco annectens* which has no range exclusively its own but appears as hybrid individuals along the southern boundary of the range of *mearnsi* in Utah as a result of crossing with *Junco caniceps* that occurs in the same localities. Instead, these jays are to be compared with *Junco caniceps dorsalis* whose chief characters are not different from juncos to the north and to the south, the characters merely being brought together in a new combination that is stable over a considerable area.

The fact that the jays of northern Idaho are not hybrids does not preclude the possibility that the race may have arisen at some time in the past by hybridization, although this is by no means the only explanation of its origin. Origin of systematic groups by hybridization is a widely recognized principle in the evolution of plants and has been suggested in a number of groups of animals. Contrary to Dwight's procedure in dealing with juncos (Bull. Am. Mus. Nat. Hist., 38, 1918, pp. 269-309), hybrid origin of a race that has since become stable should not affect the taxonomy any more than should a person's views as to origin by mutation, orthogenesis, or natural selection modify the nomenclature. Individuals of immediate hybrid derivation should of course be removed from the generally accepted scheme of trinomial designations.

To conform to current practices and in the apparent absence of an

available name, the Canada Jay populations of northern Idaho may be formally designated:

Perisoreus canadensis bicolor subsp. nov.

Type.—Male adult; no. 62817, Mus. Vert. Zool.; 4 miles west Meadow Creek, elevation 3000 feet, Boundary County, Idaho; July 30, 1932; collected by Dean H. Blanchard; orig. no. 198.

Measurements of type.—Wing, 144.2 mm.; tail, 140.7 mm. (measured from between bases of rectrices); bill (from distal edge of nostril to tip), 14.6 mm.; tarsus, 33.4 mm.

Diagnosis.—Head white except occiput which is black, paling to deep neutral gray anteriorly and posteriorly; feathers of orbital and loral regions with ends of shafts black, so producing in many cases a mass effect of pallid neutral gray as in *capitalis;* occiput separated from the gray areas of back by white or pallid gray except in mid-dorsal line where occiput merges with gray of back passing through blackish slate and dark neutral gray to deep neutral gray; entire back and margins of coverts and secondaries deep neutral gray as in *P. c. canadensis;* remainder of wing and tail feathers dark neutral gray with primaries approaching dusky neutral gray; margins and tips of wing coverts, remiges and rectrices tipped with dull white.

Chin, throat and extreme anterior part of breast white, changing abruptly to light mouse gray on posterior part of breast; line of demarcation more positive than in any other race of the species; light mouse gray extends uniformly over flanks and belly; crissum pallid neutral gray.

Juvenal plumage with white or light gray pileum as in *capitalis.*

Size small, much as in typical *canadensis* but wing and tarsus averaging slightly smaller. In longitudinal section of the Rocky Mountains minimum size is reached in *bicolor* and adjoining *P. c. canadensis* of central British Columbia (see table, p. 292).

Comparisons.—Size, and tone and hue of coloration as in *P. c. canadensis* of central British Columbia, but dark color of occiput not surrounding or even extending to orbit; entire pileum, anterior breast and throat white, the white of head above and below standing in sharper contrast to dark grays and black of occiput and body; collar purer white and broader.

Markings of head similar to *capitalis,* but occiput ranging from black to deep neutral gray instead of from deep mouse gray to mouse gray; extent of occipital area approximately same, although darker color causes it to be more prominent; wing and tail feathers dark neutral gray rather than deep mouse gray; white collar less extensive posteriorly; back deep neutral gray rather than light mouse gray and mouse gray; underparts sharply contrasted antero-posteriorly, the posterior region being the same color as back of *capitalis.* Average size of *bicolor* much smaller; wing 7.8 per cent, tail 4.8 per cent, bill 8.2 per cent, and tarsus 5.7 per cent smaller.

The individuals in the series from northern Idaho and from Utah and Colorado that are the basis for the above comparison in size, show some overlap

in the measurements of tarsus, bill and tail; there is no overlapping in the wing measurements in these samples, the individual variation being relatively less in this dimension despite the fact that groups of first-year and fully adult birds that probably would show different average wing lengths can not be segregated in the series available.

Distribution.—In designating the distribution of subspecies generally, the writer feels that it is much more important to stress the region or faunal area in which the race has its center of differentiation or in which

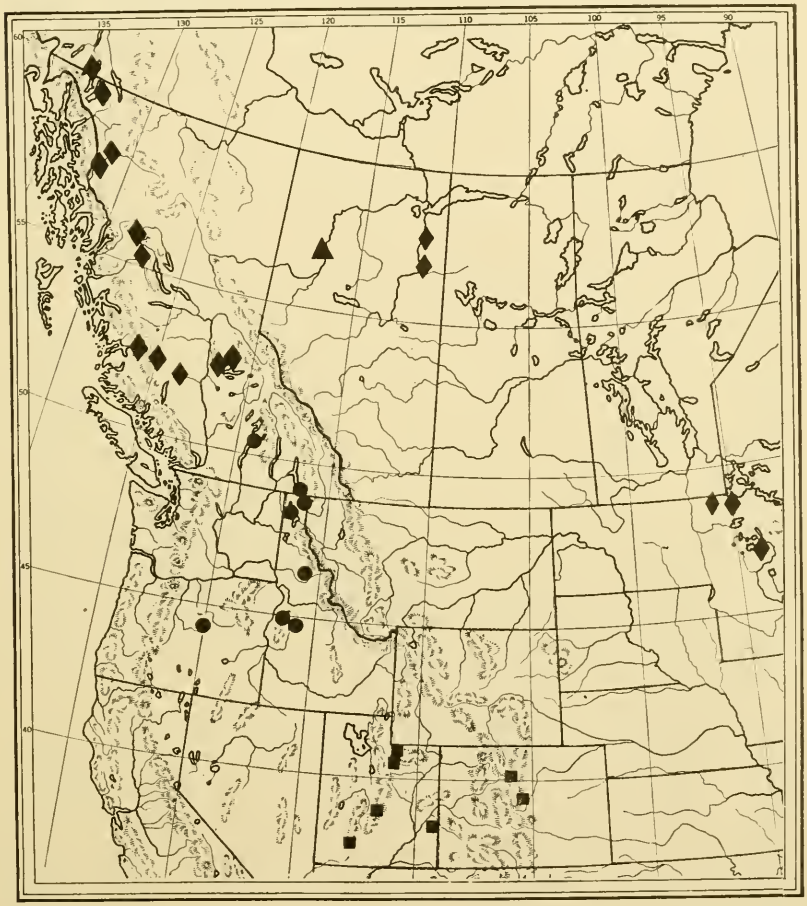

Fig. 2. Map showing distribution of Canada Jays. Each symbol represents a locality from which specimens have been examined; kinds of symbols indicate the race to which specimens belong or the race they most resemble. Squares—*capitalis;* dots—*bicolor;* diamonds—*P. c. canadensis;* triangle—*albescens.*

it shows its characters in most striking form than it is to try and set up what, of necessity, usually are arbitrary boundaries for the race in the zones of intergradation surrounding it.

The race *bicolor* is distributed primarily, then, in the relatively humid forest regions of northern Idaho, the principal trees of this forest being Engelmann spruce, western white pine, western larch and Douglas fir. This faunal and floral region extends into northeastern Washington, but no birds have been examined from that State. The race appears to follow this forest association into the Kootenay district of British Columbia, certainly in the region of Creston, from which locality specimens have been examined. A bird from Okanagan, British Columbia, shows the essential features of this race. The eye is surrounded by white but the breadth of the occipital band is perhaps slightly greater than in the majority of Idaho birds. If one were required to place a name on this individual, it would certainly be called *bicolor*. In central Idaho, *bicolor* appears to extend to Washington, Adams and Valley counties, the southern limits of the humid forest areas of the northern part of the State. Birds from this section, although in worn plumage, match the worn plumages of birds farther north and do not resemble worn *capitalis*. Five males from Adams County measure no larger than the maximum of the series from northern Idaho and the series of *P. c. canadensis* from central British Columbia. These five do, however, average two per cent longer in wing. Whether this difference would hold true in a larger sample of the population perhaps is doubtful, but I suspect that the difference indicates the beginning of an increase in size to the south and east (see table). One male bird from Weippe which is not measurable because the extreme tip of the wing is in molt, evidently would, with feathers fully grown, exceed the measurements of *bicolor* so far given, and undoubtedly would reach the minimum of true *capitalis*.

Canada Jays occur regularly in certain sections of the Blue Mountains that extend in Oregon westward on a latitude with Adams County, Idaho. A pair of birds in worn plumage from Ochoco Ranger Station, Crook County, Oregon, at the western end of these mountains seem to agree fairly well with comparable plumages of *bicolor,* although they are somewhat lighter. They show no approach to *P. obscurus griseus* of the adjacent Cascade Mountains. Final decisions regarding jays of this region must await examination of fresh plumages. However, it is to be observed that the male of the pair is almost as large as the bird mentioned above from Weippe, Idaho. Its size, wing 151.0 mm., is intermediate between

capitalis and *bicolor*. The size of the female is normal for *bicolor* females. Although perhaps not typical of *bicolor,* I believe these rather unsatisfactory samples most resemble this race, but occur in a different faunal area and show an approach to *capitalis*. It seems unlikely on geographic grounds that this approach to *capitalis* can be the result of any direct mixture with populations of this latter form. It may be that they are merely a westward continuation of populations of jays intermediate in character that probably occur in Idaho in scattered localities south and east of Adams County.

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TRANSPOSED HINGE STRUCTURES IN LAMELLIBRANCHS

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INTRODUCTION

In the course of study of a collection of Eocene fossils from Claiborne Bluff, Alabama, the senior author of this paper noticed two valves, one right and one left, of the lamellibranch *Venericardia parva* Lea, in which the dentition is partially transposed. Subsequently, the authors made an examination of more than five thousand lamellibranch valves, representing both recent and fossil shells, in search of further examples of hinge-transposition. We have found a total number of twenty-six valves exhibiting this variation.

Study of these specimens has revealed some hitherto unreported facts regarding the principles of hinge-transposition. Therefore in this paper, we shall describe and discuss these specimens, and shall present such conclusions as seem justified by the data assembled.

Citations to the literature are made by author, date, and page, referring to the list at the end of the paper.

DEFINITION OF TERMS

A transposed lamellibranch hinge is defined as one that exhibits in the right valve the hinge elements normally occurring in the left valve, and *vice-versa*. The relations of the individual teeth to one another, and to the bilaterally symmetrical parts of the shell are exactly similar to the relationships which are present in a normal individual. Thus, the interior of an abnormal valve presents the appearance of a mirror-image of the interior of the opposite normal valve.

The terms "inverted," "reversed," and "transposed," have been used previously in the literature to designate lamellibranch valves exhibiting entirely or in part the morphologic characters normal to their opposite valves. The first two expressions have been most commonly used, but the third, "transposed," has been employed by Jeffreys (1863, p. 317)

[1] Read before the Pacific Coast Section, Paleontological Society of America, April 8, 1933, Los Angeles.

and Fischer (1887, p. 109). The latter term seems more appropriate, suggesting the effect of a *carrying-over* of morphologic characters from the valve in which they normally occur to the opposite valve. Therefore, we shall use the term *transpose* and its derivatives to designate the abnormal hinges here discussed.

In this paper, unless otherwise stated, the unqualified term *transposition* will refer to the dentition and not to the valve as a whole, while *partial transposition* will imply transposition of a part of the dentition.

ACKNOWLEDGMENTS

In the course of this study, we have benefited by the interest and criticism of W. P. Woodring of the United States Geological Survey. Many of the references cited in this paper were made available to us by Ralph Stewart, also of the U. S. Geological Survey. Julia Gardner and Edgar Bowles permitted us to make excerpts from their paper, "An Inverted Hinge in a Left Valve of the *Venericardia planicosta* Group." The illustrations were prepared by John L. Ridgway, scientific illustrator for the Division of Geology and Paleontology, California Institute of Technology. Finally, the work has been carried on under the supervision of Chester Stock, Professor of Paleontology at the California Institute of Technology. We gladly acknowledge our indebtedness for the assistance we have had from these sources.

REVIEW OF PREVIOUS LITERATURE

In this section we shall review briefly all literature on the subject of transposed lamellibranch shells available to us. We shall also mention some papers cited by other authors, but to which we do not have access. References to supposed cases of transposition occurring among the Chamidae are omitted, as these examples apparently do not represent transposition as defined in this paper.

MOQUIN-TANDON (1855, p. 322) placed the species *Unio sinuatus* in a list headed: "Espèces à spire dextre devenue sénestre," designating the species included in the list as examples of "inversion."

AGASSIZ (1859) noted a case of "reversion" in *Unio ligamentinus* (Lamarck). The dentition in his specimen was apparently completely transposed.

ISAAC LEA (1860) discussed abnormal dentitions in a considerable number of Recent valves of *Unio*. A list was presented showing *individual*

abnormalities as follows: (1) single lateral tooth in each valve, 4 specimens belonging to 4 species; (2) single lateral tooth in the left, and double lateral in the right valve, 6 specimens belonging to 5 species; (3) double lateral tooth in both valves, 9 specimens belonging to 2 species; (4) treble lateral tooth in the left, double in the right valve, 1 specimen; (5) treble lateral tooth in the left, and partly treble in the right valve, 2 specimens belonging to 2 species. Another list was given, including species of *Unio* in which the following dentitions are *specifically* characteristic: (1) cardinal tooth single in both valves; (2) cardinal tooth double in the right, single in the left valve; (3) cardinal and lateral teeth double in both valves; (4) lateral tooth double in the right valve only; (5) lateral tooth double in both valves; (6) lateral tooth treble in the left, and double in the right valve; (7) cardinal tooth treble in the right valve; (8) cardinal tooth treble in both valves, and lateral tooth treble in the right and double in the left valve. These data together with those furnished by other writers on abnormal *Unio* hinges suggest that the dentition of this genus is subject to many variations, some of which *may or may not* constitute hinge-transposition as we define it. Similarly, the *Unio* we describe (below, p. 309) may or may not constitute an example of true hinge-transposition. Lea emphasized the fact that hinge abnormalities in *Unio* may be either individual variations or specific characters. He referred to two papers that he had previously published ("Trans. Am. Phil. Soc. in 1827 * * * and in 1829") discussing aberrant Unios. We have not seen these papers.

JEFFREYS (1863) discussed a specimen of *Astarte compressa* Montagu (p. 317), which he described as displaying *"partial transposition."* By this expression Jeffreys evidently meant transposition *of a part of the valve;* whereas in the present paper, the same expression refers to *transposition of a part of the hinge.* He referred to two examples of transposition mentioned "by Gray in the 'Zoological Journal' and 'Philosophical Transactions.' " We have not seen these references. Jeffreys also stated (p. 319) regarding *A. triangularis* Montagu, that "the hinge is now and then reversed, as in *A. compressa.*"

FISCHER (1880) recorded a specimen of *Tellina plicata* Valenciennes in which the posterior extremities of the valves curved to the left instead of to the right, as in normal specimens. Other external characters were also transposed. No mention is made of the dentition.

BEECHER (1883, p. 52) mentioned "reversion" of teeth in Unios

"which have the cardinal and lateral teeth interchanged in the valves." He cited the following species in which Prof. R. Ellsworth Call had observed "reversion:" *Unio complanatus, Unio rubiginosus,* and *Unio cahawbensis.*

Fischer (1887, p. 109) again cited "inversion" in many specimens of *Tellina plicata* Valenciennes, "dont les valves étaient transposées." Transposition of external parts was mentioned; but no information was given regarding the teeth.

Dall (1890-1903, p. 1006) stated, in a general discussion of the genus *Tellina*: "It occasionally happens that the hinge of an individual will be reversed with respect to the valves of normal specimens, but I have found no species in which the hinge is habitually reversed." Again, (p. 1482) in discussing the Astartidae, he stated: "A peculiarity which has been noticed in several of the genera of Astartidae is the tendency to reversal of the hinge-teeth in relation to the valves, the dentition normal to the right valve being found in the left, and *vice-versa.* This peculiarity is especially notable in the case of *Goodallia,* where, out of one lot examined, nearly one-third had the hinge reversed." In another paper (1903, p. 934) he stated regarding *Astarte*: "The teeth of the hinge are frequently reversed as regards the valves."

Mason (1894, pp. 340, 341) stated: "in the lamellibranchs, one shell, viz. that to the left when the animal is walking is a dextral, and the opposite one a sinistral spiral. In a few cases the reversal of this rule has been observed, as in two specimens of *Lucina childreni* in the Tankerville collection." This is probably a case of transposition of the valves, but no details are given.

Sykes (1905, p. 270) mentioned "reversed" Chamas, and referred to Fischer (1880) and Jeffreys (probably 1863, pp. 317, 319).

Reynell (1908) figured and briefly discussed a "left valve of *Astarte mutabilis* Searles Wood, from the Pliocene (Coralline Crag) of Suffolk," showing "the hinge-dentition of the right valve." An examination of this figure shows that this is a case of partial hinge-transposition, the cardinal and anterior lateral teeth being transposed, the posterior laterals being normal.

Pelseneer (1920, pp. 54, 55) stated that there are among the lamellibranchs numerous "exemples d'inversion," characterized notably by the presence in the left valve of teeth normal to the right, and *vice-versa.* He cited 13 papers, two of which, dealing with *Chama pulchella,* and Pectens

lying on the wrong side, are irrelevant to this paper. We have discussed 8 of these references above. The remaining 3 papers, Deshayes (1850), Fischer (1906), and Anthony (1905), are not available to us.

DAVIES (1925) discussed "inversion" in the Astartes and Chamas. He stated that the symbols of the Munier-Chalmas-Bernard system of notation which are applied to the teeth of a normal right valve should be used for the teeth of the left valve in the case of true hinge-transposition, and *vice-versa*. Previous authors had attempted to use the same notation for the teeth of the right valve whether transposed or not; and similarly for the left valve. Davies also suggested that Rudistids, previously supposed to show hinge-transposition, are not true cases of this phenomenon.

HANNA (1925, p. 287, pl. 38, fig. 4) mentioned paired valves of *Venericardia hornii* Gabb showing transposed dentition. He figured the hinge of the right valve.

GARDNER AND BOWLES (1932) described a left valve of the *Venericardia planicosta* group which shows an "inverted" hinge. A review of part of the literature on the subject of hinge-transposition is given. They conclude that hinge-transposition is a systematic abnormality and not simply a displacement of the teeth normally found in the valve concerned. The hinge of the subgenus *Microstagon* Cossmann is discussed as possibly related to transposition. They cite Bernard (1897, p. 564) who stated, in connection with a discussion of the Chamidae, that each tooth has its own individuality, and that he had not seen any case of dentition having been transferred from one valve to the other. Bernard referred indefinitely to work of Munier which may have significance in connection with transposition. Two papers not available to us are cited by Gardner and Bowles: Oedner (1919) and von Vest (1899). According to Gardner and Bowles, Oedner considered that hinge-transposition represents simply a displacement of the hinge-elements from their normal order in the hinge in which they normally occur. Von Vest figured a right valve of *Astarte corrugata* Brown, Recent, which indicates true transposition of the hinge.

DESCRIPTION OF MATERIAL

The shells showing the transposed hinges herein described belong to the following genera: *Venericardia,* sensu lato, *Astarte, Transennella,* and *Unio*. Approximately 2000 shells from various other genera, but mostly representing common forms of Venerids and Tellinids, were examined. These yielded no examples of transposition.

In the following descriptions, the material is divided into four groups, based on the number and structure of the hinge-elements present, and on the way in which these elements have been transposed. These groups are: (1) cardinals and anterior laterals transposed, posterior laterals normal; (2) cardinals and anterior laterals transposed, posterior laterals absent; (3) cardinals and anterior laterals normal, posterior laterals transposed; (4) cardinals normal, anterior laterals absent, posterior laterals transposed. Group (2) may represent only a special case of group (1), and group (4) only a special case of group (3).

Certain points should be emphasized with reference to this grouping. Most of the specimens described in this paper exhibit *partial* transposition, in which only a part of the dental armature present has been transposed. No hinge containing all three dental groups, namely cardinal teeth, anterior laterals, and posterior laterals, is completely transposed. One hinge in which posterior laterals are absent is completely transposed.

(1) Cardinals and Anterior Laterals Transposed, Posterior Laterals Normal.

Twenty-one of the twenty-six valves showing transposed dentition fall within this group. These all belong to the families Carditidae and Astartidae.

Carditidae

Nineteen valves showing transposed dentition of this type were found in an examination of approximately 3700 specimens of Carditidae. The specimens represent the following species: *Venericardia parva* Lea, (plate 19, figs. 1-4) Upper Eocene, Claiborne Bluff, Alabama, six right valves and two left valves; *"Venericardia" granulata* Say, Pliocene, Walkers Bluff, Cape Fear River, North Carolina, two left valves; and *"Venericardia" ventricosa* (Gould), Pleistocene, San Pedro and Santa Barbara, California, seven right valves and two left valves.

Since these three species show practically identical hinge patterns, one description will serve for all. The hinge of the normal valve contains three cardinal teeth: one large central triangular tooth extending obliquely backward from just below the umbo to the postero-ventral margin of the hinge plate; one long narrow posterior cardinal situated just below the nymph, and diverging from it posteriorly by a small angle; and one small pointed anterior cardinal situated upon the lunular wall which borders anteriorly the socket lying in front of the central cardinal. The

normal left hinge contains two cardinal teeth: one small trigonal anterior cardinal directly ventral to the beak; and a long, arched, posterior cardinal extending from the beak to the posterior margin of the hinge-plate and lying immediately ventral to the nymph. An inconspicuous anterior lateral tooth in the left valve fits into a minute, shallow anterior lateral socket in the right valve; and a tiny posterior lateral tooth in the right valve similarly fits into a small socket on the postero-dorsal margin of the left valve. The lateral teeth and sockets in these species are so small as to be practically obsolete, and are usually not to be distinguished on eroded specimens.

The individual teeth in these abnormal Carditid hinges are precisely similar to those of normal specimens. However, the cardinals and anterior laterals are found to be completely transposed, leaving only the posterior laterals normal to the hinge in which they occur. Thus, in the transposed hinges, anterior and posterior lateral sockets occur in the left valve, while single posterior and anterior lateral teeth are found in the right valve.

Astartidae

Two left valves showing transposed dentition were found in an examination of approximately 260 normal valves belonging to several species of *Astarte*. The abnormal valves belong to two species: *Astarte concentrica* Conrad, (plate 19, figs. 5-7) Yorktown formation, Miocene, Grove Wharf, Virginia, and *Astarte sima* Gardner, Miocene, Shoal River formation, Shoal River, Florida.

The following is a description of the normal dentition in these species of *Astarte*: The right valve contains one large central triangular cardinal, with weak anterior and posterior cardinals; the left valve exhibits two prominent diverging cardinals separated by the socket that receives the large central cardinal of the right valve. Two lamellar anterior lateral teeth in the right valve lie on either side of the socket that receives the single anterior lateral tooth of the left valve; while a single laminar posterior lateral tooth in the right valve fits between two posterior "clasping lamellae" in the left valve.

As in the case of the Carditids, the abnormal Astartes exhibit individual teeth which are entirely similar to those of normal valves. Similarly also, the cardinal and anterior lateral teeth are entirely transposed, while the posterior laterals remain normal. Paired laterals therefore occur in both the anterior and posterior positions in these two left valves.

(2) Cardinals and Anterior Laterals Transposed, Posterior Laterals Absent.

This group is represented by a single left valve of *Transennella stimpsoni* Dall, (plate 19, figs. 10-12) Recent, found in a collection of twenty valves of the species from the Florida Keys. So far as we have been able to determine, this specimen shows the only example of hinge-transposition reported in the Veneridae.

In the normal right valve of this species, three cardinal teeth are present. The two anterior cardinals are thin, blade-like, and nearly parallel to one another. Between them is situated the narrow socket into which fits the narrow anterior cardinal of the left valve. Immediately posterior to the median right cardinal is the deep socket which receives the bifid median cardinal of the left valve. Posterior, and somewhat dorsal to this socket lies the right posterior cardinal, a rather long, curved, laminar tooth which extends from just under the umbo to the posterior end of the hinge plate. This last tooth is separated from the nymph by a narrow and shallow groove which lodges the left posterior cardinal. Two small anterior lateral teeth separated by a deep socket form the lateral dentition of the right valve. Posterior lateral teeth are absent.

The entire interior of the abnormal left valve mentioned above corresponds exactly to a mirror-image of the interior of a normal right valve. The dentition is completely transposed.

(3) Cardinals and Anterior Laterals Normal, Posterior Laterals Transposed.

Two valves, one right and one left, of *Venericardia parva* Lea, (plate 19, figs. 8, 9) Upper Eocene, Claiborne Bluff, Alabama, show hinge-transposition of this type. The normal Venericard hinge has been described above under Group (1). Under that division it was pointed out that the normal lateral dentition of the right valve consists of an anterior socket and a posterior tooth. In the left valve, the positions are reversed, for the single tooth is anterior in position, while the socket is posterior.

The right valve included under Group (3) has the normal cardinal dentition and the normal anterior socket. The posterior border, instead of bearing a single tooth, exhibits a socket similar to that found in the posterior position in the normal left valve. Thus, the anterior and posterior sockets both occur in the right valve. The left valve similarly shows a normal cardinal dentition, and a normal anterior lateral tooth. However, the postero-lateral dentition consists of a single tooth similar to that found

on the postero-dorsal border of the right valve. Thus, the anterior and posterior lateral teeth both occur in this valve. The posterior lateral dentition in each of the two valves is completely transposed.

(4) Cardinals Normal, Anterior Laterals Absent, Posterior Laterals Transposed.

This type of transposition occurs in two paired valves of *Unio japanensis* Lea (plate 19, figs. 13-16) Recent, from Japan. Four pairs of normal valves of the same species from the same locality are included in the collection.

In the normal dentition of this species, two cardinal teeth appear in each valve. The right valve shows a weak anterior and a strong posterior cardinal. The left valve shows two cardinals of subequal size although the anterior tooth tends to be somewhat larger and longer than the posterior. Anterior lateral teeth are absent. The right valve has a single, long, straight posterior lateral which fits between two laminar posterior laterals in the left valve. In the latter, the ventral posterior lateral is the stronger of the two, and usually projects farther beyond the plane of juncture of the two valves.

The individual teeth in these two transposed hinges are similar to those of normal hinges of the same species. The posterior laterals only are transposed. Thus paired posterior laterals appear in the right valve and a single posterior lateral in the left valve. A low platform of shelly material is built up from the ventral base of the single lateral of the abnormal left valve. This platform is slightly grooved where the edge of the ventral lateral of the right valve abuts against it. The same type of structure with varying degrees of prominence is found in normal valves, and is to be interpreted as a variable structural feature occurring commonly in the Unios rather than an abnormality.

RELATION BETWEEN HINGE-TRANSPOSITION AND PRIMARY LAMELLAE

No shell examined in the course of our study exhibits complete transposition involving cardinals, anterior laterals and posterior laterals. In all specimens showing anterior laterals, these have been transposed with the cardinals. If posterior laterals are present, they are either (1) normal while the cardinal and anterior lateral teeth are transposed, or are (2) transposed while the cardinals and anterior laterals, where present, are normal. This agreement in transposition between cardinals and anterior laterals, and disagreement in transposition between these two groups on one hand and the posterior laterals on the other, may be explained on the

basis of observations made by Bernard (1895, pp. 114-116) on the development of the heterodont hinge. These observations may be summarized as follows:

The dentition of the heterodont hinge in its immediate postembryonic stage consists of anterior and posterior lateral lamellae, a pair of each in the right valve, one only of each in the left valve. Of these the anterior lateral lamellae appear first. Posterior extensions of the anterior lateral lamellae grow up under the beaks and are there reflected, forming hook-like ends. As growth continues, these hook-like posterior extensions become detached from the anterior parts of the lamellae, thus forming the cardinal teeth. The remaining anterior portions form the anterior lateral teeth. The posterior lamellae do not extend forward beyond the ligament, and give rise only to the posterior lateral teeth.

The close genetic connection shown by Bernard's study to exist between the cardinals and anterior laterals is reflected in the tendency of these two groups of hinge-elements to transpose together. Similarly, the fundamental independence of the posterior laterals relative to the other two dental groups is shown in the failure of these teeth to transpose in agreement with the remainder of the hinge.

Partial versus Complete Transposition

It has already been indicated that no example of *complete* transposition, involving cardinal teeth, anterior and posterior laterals, has been found in this study. With the possible exception of the *Unio* discussed by Agassiz (see above, p. 302), we have found no specific reference in the literature to an example of such complete transposition. On the other hand, among the published notices of transposition available to us, only that of Lea recognizes *partial* transposition as we have defined it. Lea mentions twenty-one specimens of *Unio* "that are all abnormal as regards the lateral teeth." However, the validity of Lea's specimens as true examples of transposition is questionable, (see above, p. 302). Jeffreys (1863, p. 317) used the term "partial transposition" (see above, p. 303) but in a sense different from ours. Reynell (1908, pp. 4, 5) figured a left valve of *Astarte mutabilis* Searles Wood, showing a transposed hinge. Scrutiny of Reynell's figure shows that the cardinal and anterior lateral teeth of the specimen are transposed, while the posterior laterals are normal. This is exactly the type of transposition shown in our specimens of *Astarte*. Hanna (1925, p. 287, pl. 38, fig. 4) has described and figured a right valve of *Venericardia hornii* Gabb, with a transposed hinge. Lateral teeth are seldom dis-

cernible in adult giant Venericards, and none are seen in Hanna's figure. The same may be said for the Venericard hinge described and figured by Gardner and Bowles (MS).[2]

Of the 26 valves described in this study, 25 exhibit posterior laterals. In 21 of these, the posterior laterals are normal, while the rest of the hinge is transposed. On the other hand, four valves show transposed posterior laterals, though the cardinals are normal. These figures suggest that transposition of the posterior laterals is a rather rare phenomenon compared to transposition involving the remainder of the hinge.

FREQUENCY OF HINGE-TRANSPOSITION

Hinge-transposition in lamellibranchs has generally been regarded as a very rare phenomenon—more rare in its occurrence than the comparable abnormality of inverse coiling in gastropods. Such data as we have do not support this view.

The ratio of transposed to normal hinges in 3700 Venericard valves examined in this study is approximately 1 : 180. Similarly, in 260 Astartes studied, the ratio is 1 : 130. Dall (1903, p. 1482) states in a discussion of the Astartidae: "This peculiarity [transposition] is especially notable in *Goodallia,* where out of one lot examined, nearly one-third had the hinge reversed." We have not studied sufficient material to establish even approximate ratios for *Transennella* and *Unio.*

Pelseneer (1920, pp. 37, 38) has quoted ratios of dextral to sinistral forms for several species of gastropods. Thus, *Helix pomatia* from the environs of Geneva showed six sinistral to 18,000 dextral forms, a ratio of 1 : 3,000. *Clausilia biplicata,* a normally sinistral species of land snail has an estimated ratio of dextral to sinistral forms of 1 : 150,000. Similarly, for *Clausilia bidentata,* the ratios are 1 : 3,000. Very low ratios of sinistrality are given for the two species of marine gastropods mentioned, *Littorina littorea* and *"Turbinella"* (*Xancus*) *pirum* yielding one sinistral form to several million dextral ones. High ratios of inverse coiling are given by Sykes (1905, p. 268) for certain land snails, as follows: *"Partula otaheitana* is generally reversed, while *P. vexillum* has only one in fifty, and *P. affinis* only one in several hundred sinistral."

The data cited above indicate that the ratios of transposition in the lamellibranchs we have studied are quite comparable to the higher ratios

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[2] Manuscript, illustrated by lantern slides, read before the Society of Economic Paleontologists and Mineralogists, March 24, 1932, Oklahoma City, Oklahoma.

of inverse coiling given for gastropods. This suggests that the apparent rarity of transposition is due to the obscurity of the feature rather than to an actual great infrequency of occurrence. Inverse coiling in gastropods involves the whole shell, and hence is usually at once apparent. On the other hand, a transposed lamellibranch hinge is seldom readily apparent even in well-preserved specimens, and is to be found only by careful search. These conclusions are borne out by the fact that sinistral individuals of even such exceedingly rare occurrence as that quoted above for *Littorina littorea* and *Xancus pirum* (one sinistral to several million dextral individuals) have long been known, whereas the much greater frequency of transposition we have found in Venericards (one transposed to 180 normal hinges) has been almost entirely overlooked. Jeffreys (1863, p. 319) offered the probable true explanation for the apparent rarity of this phenomenon when he said: "Probably such monsters are not exceedingly rare, but may not have been searched for."

Systematic versus Pathologic Abnormality

Two views have hitherto been expressed in the literature as to the nature and origin of transposed hinge structure: (1) that transposition is a pathologic phenomenon, to be placed in the category of disease, accidental injury, or deformity; and (2) that it is a systematic, developmental phenomenon due to simple transposition of hinge-secreting parts taking place in the embryonic stages of the individual affected.

We consider that the abnormal hinges described above represent examples of a systematic abnormality, not pathologic in its origin, in which certain of the primary lamellae from which hinge-teeth are derived have developed in the opposite valve from that in which they are normally found. The facts that teeth become transposed in groups corresponding to these primary lamellae, and that these teeth are precisely similar to those occurring in a normal hinge are considered as evidence for this opinion. The fundamental causes bringing about this transposition are unknown.

On the other hand, we have discovered in one right valve of "*Venericardia*" *ventricosa* (Gould) (plate 19, fig. 17) an abnormal hinge which we consider to be the result of pathologic derangement. The following is a description of the hinge of this valve.

Immediately ventral to the umbo is a large, obliquely triangular socket, with the more acute apex directed postero-ventrally. Bordering this socket anteriorly is the lunular wall on the inner margin of which

occurs a small inconspicuous anterior cardinal. The socket is bordered posteriorly and dorsally by a long, narrow, but rather heavy posterior cardinal, extending to the postero-ventral border of the hinge-plate from immediately in front of the umbo. A rude, low, narrow wall extends ventrally across the large median socket from a point on the ventral side of the posterior cardinal and about one-third the distance from its anterior to its posterior end, nearly to the ventral edge of the hinge-plate. The posterior cardinal is parallel to the nymph, from which it is separated by a well-marked but shallow groove. A single posterior lateral tooth and an anterior lateral socket are distinct but inconspicuous.

The small anterior cardinal tooth, the posterior lateral tooth, and the anterior lateral socket, are all similar to those normally found in the right valve of the species. However, the posterior cardinal resembles the posterior cardinal found in the normal left valve except that it is not so much undercut on the ventral side by the bordering socket. The nymph also resembles that of the normal left valve. Other less essential differences from a normal valve are discernible. The peculiar structure extending ventrally from the posterior cardinal across the median socket has no analogue in either normal valve.

The presence in this hinge of an anterior lateral socket, anterior cardinal, and posterior lateral teeth, which are similar to comparable structures in a normal right valve appears to demonstrate that the normal primary lamellae were present in this individual in its early development. That is, these lamellae apparently were not transposed. The abnormal structure of the other cardinal elements of the hinge may have resulted from a pathologic derangement or an injury suffered during the development of the posterior hook-like ends of the primary anterior lamellae. Although the posterior cardinal was developed presumably from a lamella normal to the right valve, it took a form suggesting that of the posterior cardinal normally found in the left valve because of the abnormal position in which it was forced to develop relative to the remaining hinge-elements of this individual.

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PLATE 19

Fig. 1. *Venericardia parva* Lea. Eocene. Claiborne Bluff, Ala. Approximately 10x natural size. C. I. T. Cat. No. 1362. Interior of right valve showing normal dentition. (p. 306)

Fig. 2. *Venericardia parva* Lea. Eocene. Claiborne Bluff, Ala. Approximately 10x natural size. C. I. T. Cat. No. 1363. Interior of left valve showing normal dentition. (p. 306)

Fig. 3. *Venericardia parva* Lea. Eocene. Claiborne Bluff, Ala. Approximately 10x natural size. C. I. T. Cat. No. 1364. Interior of right valve showing transposed cardinal and anterior lateral teeth. (p. 306)

Fig. 4. *Venericardia parva* Lea. Eocene. Claiborne Bluff, Ala. Approximately 10x natural size. C. I. T. Cat. No. 1365. Interior of left valve showing transposed cardinal and anterior lateral teeth. (p. 306)

Fig. 5. *Astarte concentrica* Conrad. Miocene. Grove Wharf, Va. Approximately 2x natural size. C. I. T. Cat. No. 1366. Interior of right valve showing normal dentition. (p. 307)

Fig. 6. *Astarte concentrica* Conrad. Miocene. Grove Wharf, Va. Approximately 2x natural size. C. I. T. Cat. No. 1367. Interior of left valve showing normal dentition. (p. 307)

Fig. 7. *Astarte concentrica* Conrad. Miocene. Grove Wharf, Va. Approximately 2x natural size. C. I. T. Cat. No. 1368. Interior of left valve showing transposed cardinal and anterior lateral teeth. (p. 307)

Fig. 8. *Venericardia parva* Lea. Eocene. Claiborne Bluff, Ala. Approximately 5x natural size. C. I. T. Cat. No. 1369. Interior of right valve showing transposed posterior lateral teeth. (p. 308)

Fig. 9. *Venericardia parva* Lea. Eocene. Claiborne Bluff, Ala. Approximately 11x natural size. C. I. T. Cat. No. 1370. Interior of immature left valve, showing transposed posterior laterals. (p. 308)

Fig. 10. *Transennella stimpsoni* Dall. Recent from the Florida Keys. Approximately 4x natural size. C. I. T. Cat. No. 1371. Interior of right valve showing normal dentition. (p. 308)

Fig. 11. *Transennella stimpsoni* Dall. Recent from the Florida Keys. Approximately 4x natural size. C. I. T. Cat. No. 1372. Interior of left valve showing normal dentition. (p. 308)

Fig. 12. *Transennella stimpsoni* Dall. Recent from the Florida Keys. Approximately 4x natural size. C. I. T. Cat. No. 1373. Interior of left valve showing transposed cardinal and anterior lateral teeth. (p. 308)

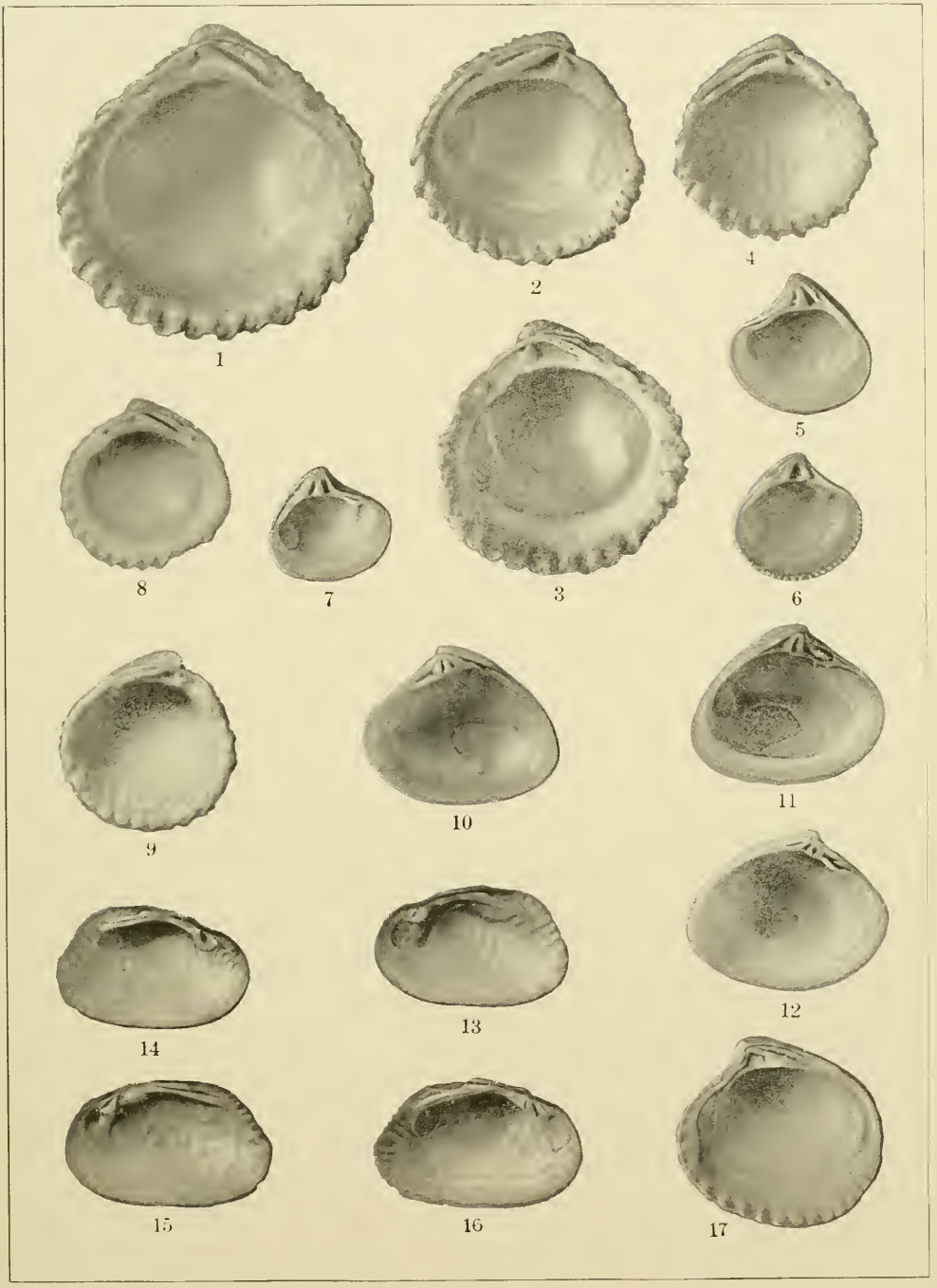
Fig. 13. *Unio japanensis* Lea. Recent, from Japan. Natural size. C. I. T. Cat. No. 1374. Interior of right valve showing normal dentition. (p. 309)

Fig. 14. *Unio japanensis* Lea. Recent, from Japan. Natural size. C. I. T. Cat. No. 1375. Interior of left valve showing normal dentition. (p. 309)

Fig. 15. *Unio japanensis* Lea. Recent, from Japan. Natural size. C. I. T. Cat. No. 1376. Interior of right valve, showing transposed posterior lateral teeth. (p. 309)

Fig. 16. *Unio japanensis* Lea. Recent, from Japan. Natural size. C. I. T. Cat. No. 1377. Interior of left valve paired with No. 1376, showing transposed posterior lateral teeth. (p. 309)

Fig. 17. *"Venericardia" ventricosa* (Gould). Pleistocene. San Pedro, California. Approximately 2x natural size. C. I. T. Cat. No. 1378. Interior of right valve with dentition showing pathologic abnormality. (p. 312)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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

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NOTES ON PARAPINNIXA AFFINIS HOLMES AND ITS ALLIES

BY

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NOTES ON PARAPINNIXA AFFINIS HOLMES AND ITS ALLIES

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The rare Pinnotherid crab, *Parapinnixa affinis* Holmes,[1] was described over thirty years ago from a single female specimen obtained by Mr. F. W. Bancroft in July, 1895, on Deadman Island, San Pedro Bay, California. The only authentic subsequent report of the occurrence of this elusive species, so far as I am aware, is that of Mr. G. E. MacGinitie, of the California Institute of Technology, who found both the male and female in a single worm tube at Newport Bay, Orange County, California, in January, 1930. This record has not yet been published. The failure of collectors to obtain and report this species during the thirty years following the discovery of the unique type specimen testifies as to its rarity, although its peculiar habitat suggests that possibly it may be more obscure than rare. During recent intensive collecting along the Southern California coast I was fortunate in securing a series of both males and females at Anaheim Landing, Newport Bay, and San Diego. This has enabled me to describe and figure the heretofore wholly unknown male and supply the much needed figures of the described but unfigured female.

"Parapinnixa affinis" was recently reported by Yokoya from Mitsu Bay, Japan, but, as explained below, his report is based upon a misidentification of a distinct and unnamed oriental species which I here rename *Parapinnixa yokoyai* in honor of Mr. Yokoya who labored under the disadvantage of having no figures or authentic specimens of Holmes' species for comparison.

Parapinnixa affinis Holmes

Female Holotype.—As S. J. Holmes' original description of the unique female type of *Parapinnixa affinis* is in a volume not readily accessible to some carcinologists I reproduce below the original description and notes, verbatim, as given by Dr. Holmes:

"Parapinnixa affinis, sp. nov."

"Closely allied to *P. nitida,* but the carapace is less than twice as wide as long, while in that species the width of the carapace is over twice its length; the

[1] Calif. Acad. Sci., Occas. Papers, Vol. 7, p. 95, 1900.

surface of the carapace is smooth and shining and the anterior margin straight. Front triangular, depressed, having a short median groove. Antennules oblique. Buccal area small, triangular, rounded in front, the posterior portion partly covered by a projection of the sternum. Chelipeds stout, smooth; hand thickened, smooth, rounded above and below; dactyl hooked at the tip and armed with a small tooth near the middle of the inner margin, the upper side smooth; pollex with two teeth at the tip. First pair of ambulatory legs larger than the others; dactyls short and stout. Next two pairs comparatively slender, having longer dactyls; last pair small, reaching about to the tip of the merus of the preceding pair; dactyls short and stout. Abdomen of the female widest at the third segment, behind which its shape is triangular, the tip broadly rounded."

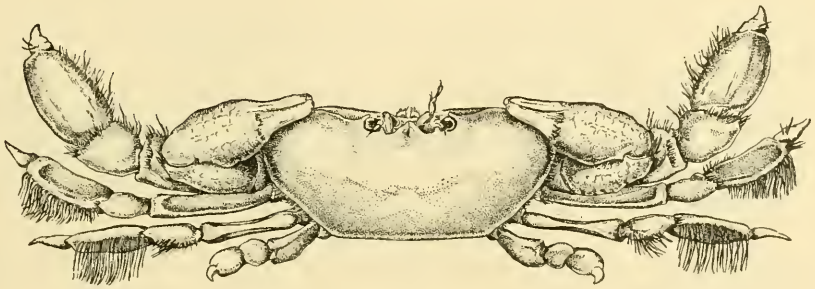
(NOTE) "Described from a single female specimen collected at Dead Man's Island, San Pedro, Calif., by Mr. F. W. Bancroft, July, 1895. Collection of the University of California."

(NOTE) "The maxillipeds in this species are similar to those of *nitida*. They were accidentally lost after I had removed them from the specimen; the palp appeared to have but two joints, but the examination was not made with sufficient care to make me feel sure of this point."

Male Allotype (Pl. 20, figs. 1 and 3; Pl. 21, figs. 1 and 6).—No. 346, collection of the San Diego Society of Natural History; Newport Bay, California; November 11, 1932; collected by Steve A. Glassell.

Description.—The carapace smooth and shining, transversely ovate and its antero-lateral corner dilated so as to make a straight line at the anterior margin. The front is broad, triangular in shape, depressed, having a short median groove and extending slightly in a dorsal aspect. The orbit is oval in shape; the inner hiatus is wide and partly filled by the basal segment of the antenna, which is very small and short. Antennule oblique. Buccal area small, broadly triangular, anterior concave, rounded in front, the posterior portion partly covered by a projection of the sternum. In the outer maxilliped, the ischium is rudimentary, while the merus is of large size and triangular in shape; at its antero-upper end a three segmented palp is articulated. Chelipeds stout, smooth; hand thickened, smooth, rounded above and below; dactyl hooked at the tip and armed with a small tooth near middle of the inner margin at basal end, upper side smooth; pollex with two teeth at the tip and a large triangular tooth extending from the tip to proximal side of center. A single row of bristles extends longitudinally from the margin of the carpus on to the pollex, while the gap of the dactyl is covered by a fringe of short bristles. First pair of ambulatory legs larger than the others; dactyls short and stout, next two pairs comparatively slender, having slightly longer dactyls; last pair small, reaching about to the tip of the merus of the preceding pair; dactyls short and stout. In the posterior three ambulatory legs the merus is compressed and broad. Abdomen with seven segments, widest at third segment, behind which its shape is triangular, with concave sides, the tip rounded; the seventh segment nearly twice as long as broad.

Color.—General appearance of carapace, light amber mottled with dark ochre. Protogastric and cardiac regions, light orange. Antero- and postero-lateral



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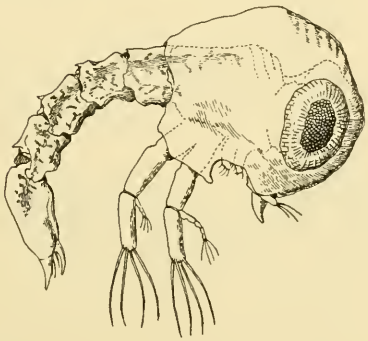

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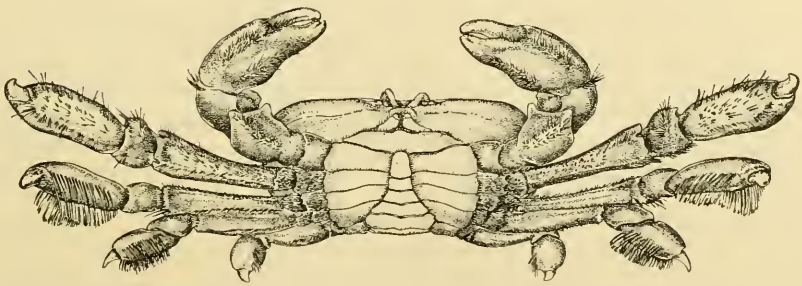

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Fig. 1. *Parapinnixa affinis*, male allotype, dorsal view.
Fig. 2. First zoeal stage of *Parapinnixa affinis*, lateral view. Hatched from ovum in the laboratory.
Fig. 3. *Parapinnixa affinis*, male allotype, ventral view.

regions mottled with a dark ochre. Meso- and meta-branchial regions, much lighter in color, almost a cream. Intestinal region a dark ochre, fingers light, toward the tip of dactylus, transparent. General color of legs, pale ochre with a greenish tinge, dactylus yellow with white tips. Abdomen a muddy yellow. Eyes red and black checkered. Hair on second and third ambulatory legs a reddish brown.

Measurements.—Allotype: Carapace 2.5 mm. long, 4.1 mm. wide. Average measurements of females, using a series of ten, are 2.5 mm. long, by 4.5 mm. wide. The largest female specimen in a group of fifty measured 3.6 mm. long, by 6.0 mm. wide.

Occurrence.—San Pedro (Holmes, female only); Newport Bay (MacGinitie, female and male); Anaheim Landing, Newport Bay, and San Diego (Glassell, females and males). Diligent search has been made on and about Deadman Island, the type locality, but without success, the former habitat not now being suitable on account of harbor refuse and oil.

Quite a number of both sexes were taken at Anaheim Landing, Newport Bay, and San Diego. Females outnumbered the males about three to one in one locality, while in another the males had a two to one majority.

In a series of one hundred specimens, 5% were albinos. This occurs irrespective of sex.

Habitat and Habits.—This minute crab is commensal with a marine worm which is now being described and named by Dr. A. L. Treadwell of the U. S. National Museum, as a new species of *Amphitrite*. This worm builds a slimy tube of mud and sand among clumps of shells and weeds at about mean low tide level in situations protected from the full force of the waves. Usually only one crab occurs in a tube but sometimes a male and female will be found together. In addition to *P. affinis*, which I have obtained only in these worm tubes, occasional visitors in these tubes include a Pollonoid worm and juvenile individuals of *Lophopanopeus lockingtoni* Rathbun. *P. affinis* itself sometimes bears colonies of a Bryozoan of the family Vesiculariidae attached to its hairy legs.

The figures reproduced on plates 20 and 21 were prepared from original drawings made with great care by Mr. Anker Petersen of Beverly Hills, under my direction. Dr. S. J. Holmes, Department of Zoology, University of California, Berkeley, kindly compared some of these figures with his type specimen and confirmed my identification.[2]

Parapinnixa nitida (Lockington)

Text figures 1, a to c

Pinnixa ? nitida Lockington, Proc. California Acad. Sci., vol. 7, 1876 (1877), p. 155, part: "male" (really female) only (type-locality, Angeles Bay, Gulf of California; type not extant).

Pseudopinnixa nitida (Lockington), Holmes, Proc. California Acad. Sci., ser. 2, vol. 4, 1894, p. 566, pl. 20, figs. 8, 9.

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[2] Letter dated at Berkeley, California, January 30, 1933.

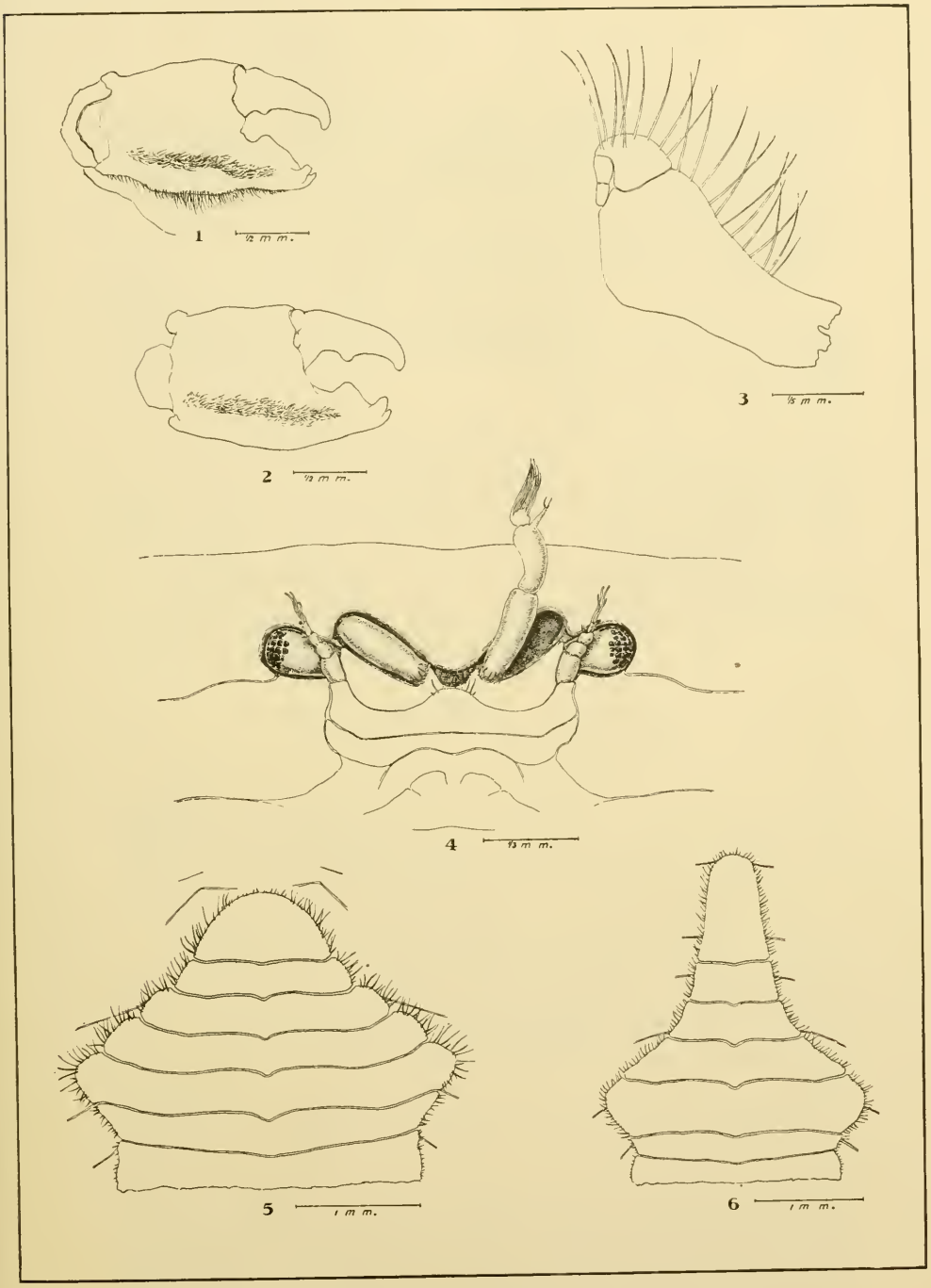

Fig. 1. *Parapinnixa affinis*, male allotype, right chela.
Fig. 2. *Parapinnixa affinis*, female, right chela.
Fig. 3. *Parapinnixa affinis*, male, outer maxilliped.
Fig. 4. *Parapinnixa affinis*, antennal and buccal area.
Fig. 5. *Parapinnixa affinis*, abdomen of female.
Fig. 6. *Parapinnixa affinis*, abdomen of male allotype.

Parapinnixa nitida (Lockington), Holmes, Proc. California Acad. Sci., ser. 2, vol. 4, 1894, p. 587, explanation of figs. 8, 9.

Parapinnixa nitida (Lockington), Rathbun, Bull. U. S. Nat. Mus., No. 97, 1918, p. 107, text-fig. 58.

Parapinnixa nitida (Lockington), Rathbun, Bull. Amer. Mus. Nat. Hist., vol. XLVIII, art. XX, 1923, p. 628, text-fig. 6.

This species was found by Mr. W. J. Fisher in Angeles Bay, Gulf of California, Mexico, and described by Lockington and redescribed by Holmes, as above. The female holotype specimen was destroyed in the San Francisco fire of 1906.

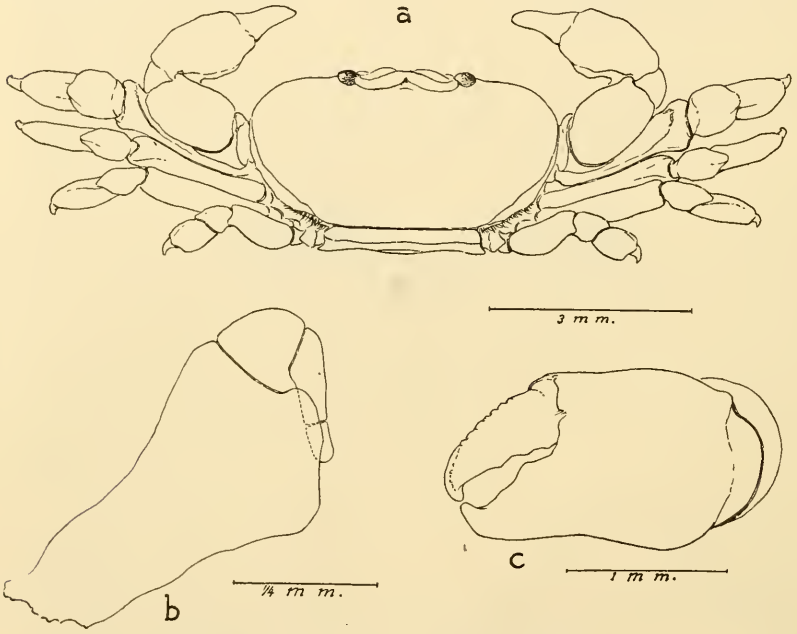

Fig. 1. *Parapinnixa nitida* (Lockington)

a, dorsal view of female from Magdalena Bay. b, left outer maxilliped. c, left chela.

The next record I have is the finding in 1911 of a male specimen, by the U. S. Fisheries Steamer "Albatross" in Pichilinque Bay, near La Paz, Lower California, Mexico, by electric light. This specimen was figured and described by Dr. M. J. Rathbun of the U. S. National Museum in 1923. So far as I am aware no other records of this little crab exist.

In December, 1931, I was fortunate enough to secure six specimens, two males and four females, in Magdalena Bay, Lower California, Mex-

ico, in from 14 to 18 fathoms of water. On June 8, 1933, at San Felipe, Lower California, Mexico, in the upper end of the Gulf of California, I took seven more specimens, one male and six females, on shore at low tide. These last were commensal with a Terebellid worm that builds a slime tube thickly incrusted with broken shell bits, on the under side of partially buried stones, at about mean low tide. One of them I am designating the neotype.

Neotype.—Female; No. 347 collection of the San Diego Society of Natural History; San Felipe, Gulf coast of Lower California, Mexico; June 8, 1933; collected by Steve A. Glassell.

Measurements.—The type specimen far exceeded in size any other specimen thus far obtained, it being, carapace measurement, 5 mm. long, by 11 mm. wide. The "Albatross" specimen, which may be regarded as the male allotype, measured 2.6 mm. long, by 5.6 mm. wide. The largest of the specimens I obtained were those taken at San Felipe. The female neotype measured, carapace, 3.5 mm. long, by 7 mm. wide. The male measured, 2.2 mm. long, by 3.8 mm. wide.

Color.—Carapace, ground color golden ochre, covered with a number of red spots and also numerous fiber-like designs black in color, which are also scattered over the chelipeds and ambulatory legs. The general appearance is of moss agate. Ventral side, pale yellow, almost cream.

Parapinnixa yokoyai new name

Text figures 2, a to d

"*Parapinnixa affinis* Holmes," Y. Yokoya, Science Repts. Tôhoku Imperial Univ., Ser. 4, Biology, Sendai, Japan, Vol. 3, no. 4, fasc. 2, pp. 773-775, text fig. 5 a-d, Nov., 1928, "On the line between Benten Isl. and Cape Kurosaki, off Shukunobe 16 fms. Mud. August 10, 1926. 1 female."

A comparison of Yokoya's figures of "*affinis*" (which I reproduce here, see text figs. 2a-d) with the California specimens in my collection and with the figures on Plates 20 and 21, shows that the Japanese *Parapinnixa* is specifically distinct from the Californian *P. affinis* Holmes. In order to correct this anomalous report of *affinis* in oriental waters, I rename the Japanese crab *P. yokoyai.*

Some of the differences between *P. yokoyai* and *P. affinis* are as follows:

P. yokoyai is almost twice the size of *P. affinis* which has no minute teeth on the cutting edge of the dactyl of the cheliped as in *P. yokoyai. P. yokoyai* has no large tooth on the pollex of the cheliped as in *P. affinis.* In *P. affinis* the immovable finger of the cheliped is bidentate at the tip, while the text figure of *P. yokoyai* shows two teeth on the pollex, but the description does not mention this. The

third segment of the abdomen of *P. affinis* is the widest, while in the text figure, but not in the description, the third and fourth segments of the abdomen of *P. yokoyai* are of equal width at their upper and lower extremities respectively. The seventh segment of the abdomen of *P. yokoyai* is triangularly rounded, while in *P. affinis* this segment is broadly rounded.

The foregoing three species are the only ones known in the Pacific Ocean. In the Atlantic the genus is represented by the following three species:

Parapinnixa hendersoni Rathbun
Parapinnixa bouvieri Rathbun
Parapinnixa beaufortensis Rathbun

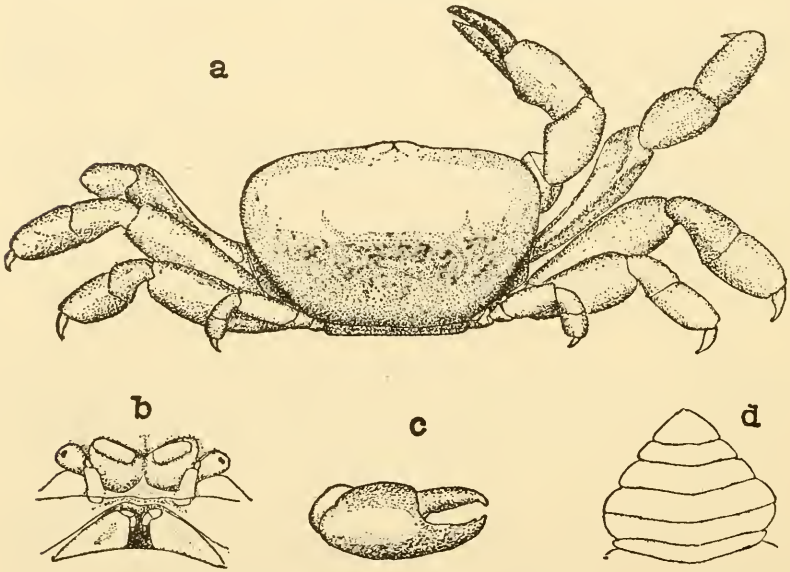

Fig 2. *Parapinnixa yokoyai* new name

a, entire animal. b, antennal and buccal area. c, chela. d, abdomen of female. (a x3; b x6; c, d x4). These figures are reproductions of Yokoya's original text figures of "*Parapinnixa affinis* Holmes."

28 898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 28, pp. 331-344, plates 22-26

DESCRIPTIONS OF FIVE NEW SPECIES OF BRACHYURA COLLECTED ON THE WEST COAST OF MEXICO

BY

STEVE A. GLASSELL

Research Associate in Crustacea, San Diego Society of Natural History

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SAN DIEGO, CALIFORNIA

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DESCRIPTIONS OF FIVE NEW SPECIES OF BRACHYURA COLLECTED ON THE WEST COAST OF MEXICO

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INTRODUCTION

In the winter of 1931-32 it was my privilege to be a member of a party of scientists aboard the motor schooner "Petrel" during a cruise along the west coast of the peninsula of Lower California and into the Gulf of California, Mexico. As but relatively few collectors of Decapod Crustacea have had the opportunity of making large collections in this region I enjoyed rather exceptional advantages which have resulted in obtaining a large number of specimens from many different localities. One of the purposes of the cruise was to visit all of the islands in the Gulf and many of the harbors with the hope that new information on the geographic distribution of species might be obtained thereby. Although but a small amount of dredging was done, mostly in shallow water, it proved richly productive, and the results of the cruise as a whole included a large number of new locality records, some of which extended the hitherto known distribution of tropical species several hundreds of miles northward. In all, eight new species of Brachyura were discovered, of which the following five are the first ones to be published.

I am indebted to Dr. Mary J. Rathbun of the United States National Museum, for her unfailing cooperation and valued council, and for her diagnoses of several troublesome species. I am also indebted to Mr. Anker Petersen for his artistic drawings of Plates 22-26, which portray the proportions and detail with a fidelity seldom excelled.

DESCRIPTIONS OF NEW SPECIES

LEUCOSIIDAE

Ebalia magdalenensis Rathbun, n. sp.

Plate 22

Type.—Female, holotype; Cat. No. 67429, U. S. National Museum; Magdalena Bay, Marcey Channel, Lower California, Mexico, 18 fathoms; December 3, 1931; collected by Steve A. Glassell. One paratype, female, from Magdalena Bay, No. 353, collection of San Diego Society of Natural History; one paratype, female juvenile, from Magdalena Bay, in collection of Steve A. Glassell, Beverly Hills, California.

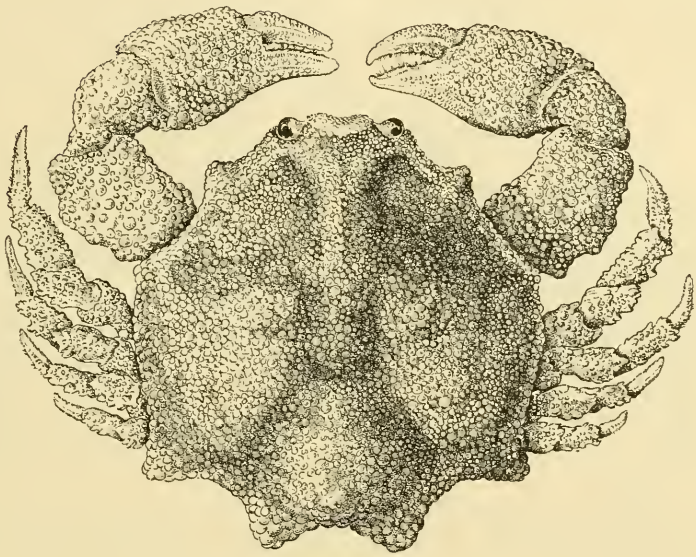
Diagnosis.—Length and breadth subequal; highest elevations of carapace in front of middle. Superior hepatic projection slight.

Description.—Carapace covered with crowded granules except on the anterior part of the median ridge. Front with 2 shallow, obtuse-angled lobes; orbits oblique, behind the front. Median carina broad and blunt, concave in profile, narrowing toward middle of carapace, indicating the mesogastric region. Hepatic prominence very slightly produced; antero-lateral cavity suboblong, granules largest in the deepest part. The highest point of the branchial region is at its inner anterior angle, from which a concave line trends toward the lateral angle of the carapace. Behind this, the surface is convex and uneven, showing 2 low elevations. A right-angled tooth at postero-lateral angle. A deep furrow either side of the cardiac region which is surmounted by a blunt lobe. Intestinal lobes broad, rectangular, blunt. Subhepatic prominence prominent, projecting downward and forward, tip lobiform. Chelipeds granulate, coarser on merus, becoming finer toward fingers; a few lobes on posterior margin of merus, manus coarsely granulate above, fingers slender, hairy on prehensile edge. Ambulatory legs tuberculate, one row of tubercles on merus, 2 rows above on carpus and propodus, 1 row below on propodus.

Color.—Preserved specimens show 4 red dots in a square on the female abdomen, and red color on distal half of fingers.

Measurements.—Holotype: Length of carapace on median line 11 mm., length to tip of intestinal lobe 11.7 mm., width 11.3 mm.

Material examined.—3 specimens from Magdalena Bay, Lower California, Mexico; 1 specimen, female juvenile, from Concepción Bay, Gulf of California, Lower California, Mexico, 15 fathoms, January 19, 1932.



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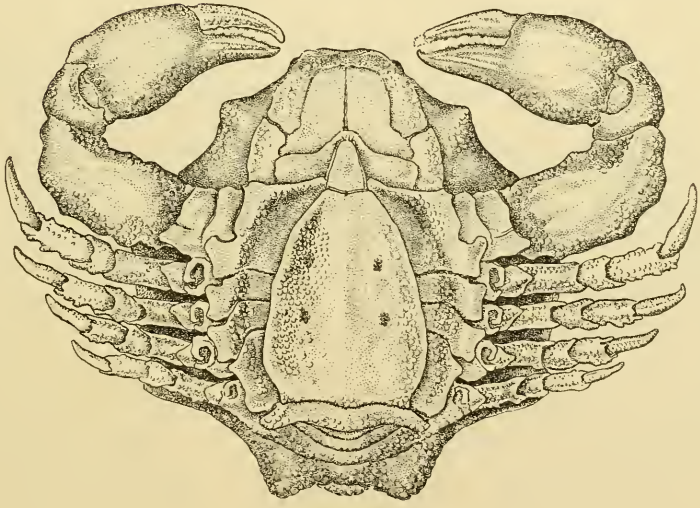

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Ebalia magdalenensis Rathbun, n. sp. (x5)

Fig. 1. Female holotype, dorsal view.
Fig. 2. Same specimen, ventral view.

GRAPSIDAE

Cyclograpsus escondidensis Rathbun, n. sp.

Plate 23

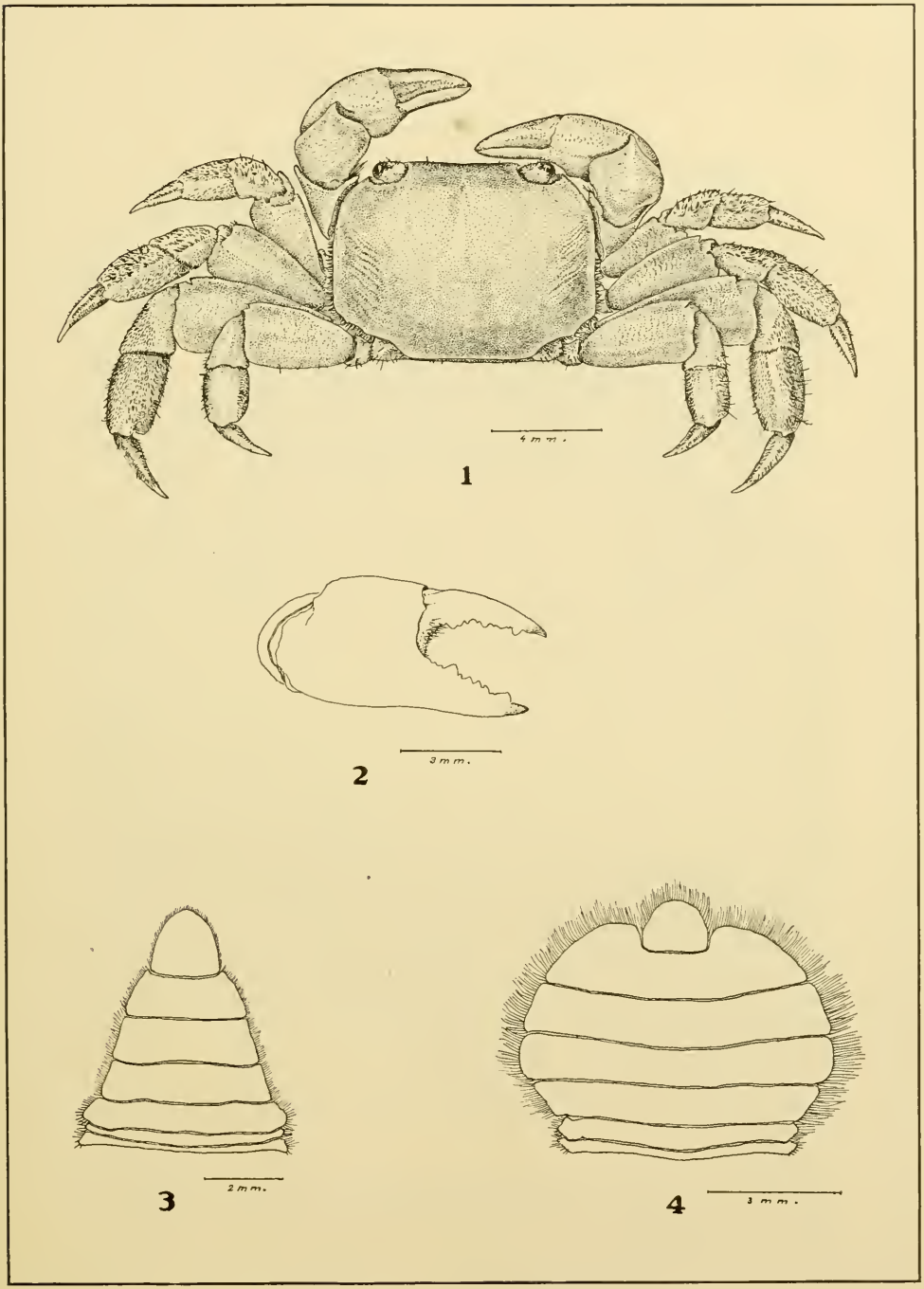
Type.—Male, holotype; Cat. No. 65863, U. S. National Museum; Puerto Escondido, Gulf of California, Lower California, Mexico (lat. 25° 48′ N., long. 111° 18′ W.), in holes at high tide mark, under rocks; December 19, 1931; collected by Steve A. Glassell. Holotype and one female paratype (No. 65864) in U. S. National Museum; one male and one female, paratypes, Nos. 348 and 349, collection of San Diego Society of Natural History; five males and five females, paratypes, in collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—Surface of front rough. A deep postorbital sulcus. A tooth on merus joints of legs.

Description.—Length about ¾ of width. Carapace widest in anterior half. Front deflexed. Anterior and antero-lateral regions rough with fine granules; remainder of carapace covered unevenly with small unequal punctae. Chelipeds and legs hairy at base, distal half of legs hairy. Wrists rough above, palms coarsely punctate, each finger with a large prehensile tooth proximal to the middle. Merus of legs widening distally, granulate, subterminal tooth very short.

Measurements.—Holotype: Length of carapace 7.8 mm., width of anterior half 10 mm. Largest paratype, length 9.8 mm., width on anterior half 12.2 mm.

Material examined.—14 specimens from Puerto Escondido, Lower California, Mexico.



Cyclograpsus escondidensis Rathbun, n. sp.

Fig. 1. Male holotype, dorsal view.
Fig. 2. Male holotype, right chela.
Fig. 3. Male holotype, abdomen.
Fig. 4. Female paratype, abdomen.

MAJIDAE

Mithrax (Mithrax) sonorensis Rathbun, n. sp.

Plate 24

Type.—Female, holotype; Cat. No. 65865, U. S. National Museum; San Pedro Bay, Sonora, Mexico, among rocks and weed at low tide; December 25, 1931; collected by Steve A. Glassell. Two males (1 juv.) collected at Miramar Beach, near Guaymas, Sonora, Mexico, December 23, 1931, paratypes, one (No. 350) in collection of San Diego Society of Natural History, one in collection of Steve A. Glassell, Beverly Hills, California.

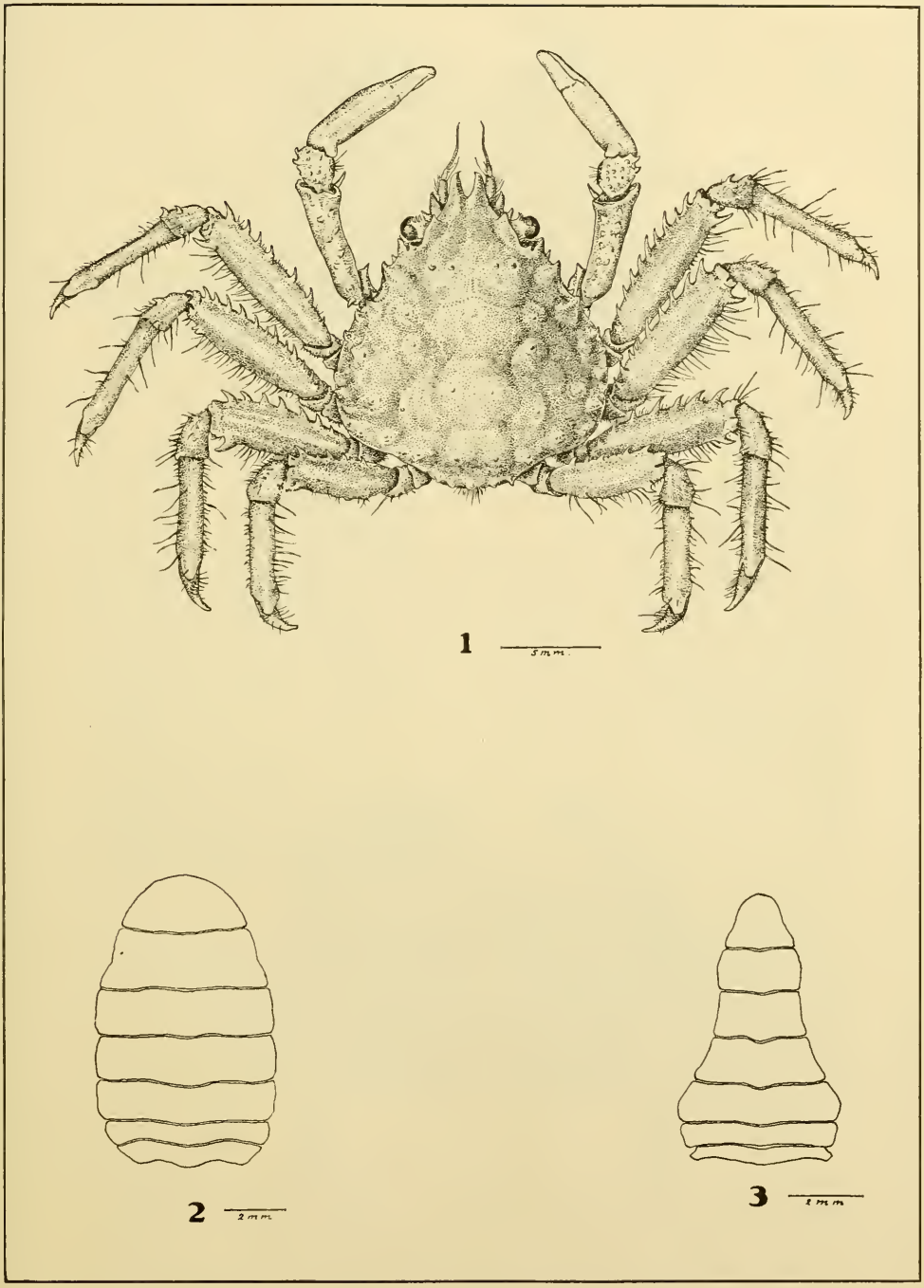
Diagnosis.—Carapace without lateral angle. One supraorbital spine between preorbital and postorbital spines. Two lateral rows of spines on carapace. Three marginal spines on basal antennal article.

Description.—Carapace about 5/6 as wide as long. Rostrum as long as wide, armed with 2 slender spines directed forward and gradually narrowing to the tips which have a small sharp spinule directed inward. Preorbital spine half as long as rostral spines, slightly curved, sharp pointed, and directed obliquely outward; the adjacent orbital spine is also visible in dorsal view. Supraorbital tooth blunt. The principal row of lateral spines consists of 5 stout equidistant spines including the outer orbital spine and curves inward on the carapace at its widest. Below and subparallel to it is a second row of very small sharp spines which trends toward the buccal angle. On the postero-lateral and posterior margin a row of about 14 small, unequal spines curving forward. Dorsal surface closely and finely punctate; 2 blunt conical spines on each protogastric region arranged transversely, the median space more than twice as wide as the lateral ones; 3 low conical branchial elevations, of which 2 are alongside the cervical suture, the anterior one spine-tipped, and the third is opposite the cardiac-intestinal suture. On the pterygostomian region a row of 4 small, sharp spines leading to the anterior third of the buccal cavity. Chelipeds and legs armed with sharp spines; 1 spine at extremity of ischium of cheliped, a row of 7 long spines on upper margin of merus, 2 additional terminal spines and one spine at distal third of lower margin; merus of ambulatories armed with long spines above, and an inferior spine near distal extremity; propodi very slender, 3 times as long as the slender, curved dactyli which are armed below with a row of minute spines. Legs and chelipeds, excepting the manus, hairy.

Color.—Preserved specimen reddish, legs banded with red.

Measurements.—Holotype: Length to tip of rostrum 17.6 mm., width 14.4 mm.

Material examined.—1 specimen from San Pedro Bay, Sonora, Mexico; 2 specimens from Miramar Beach, Sonora, Mexico; 2 specimens, one male and one female, both small, taken at the head of Concepción Bay, Lower California, Mexico, January, 1932.



Mithrax (*Mithrax*) *sonorensis* Rathbun, n. sp.

Fig. 1. Female holotype, dorsal view.
Fig. 2. Female holotype, abdomen.
Fig. 3. Male paratype, abdomen.

XANTHIDAE

Neopanope peterseni Glassell, n. sp.

Plate 25

Type.—Male, holotype; Cat. No. 67478, U. S. National Museum; Puerto San Carlos, Sonora, Mexico (a small bay opposite the Island of San Pedro Nolasco, in the Gulf of California), on beach under stones at low tide; December 24, 1931; collected by Steve A. Glassell. Holotype and one paratype (Cat. No. 67479) in U. S. National Museum; two male paratypes, Nos. 351 and 352, collection of San Diego Society of Natural History; four males, one female, paratypes, in collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—Dactylus of larger hand has a tooth at base of prehensile edge. The sides of the 3rd tooth meet at an obtuse angle; the 4th and 5th teeth are right-angled. Terminal segment of male abdomen subtriangular, not projecting sideways beyond penult segment.

Description.—Carapace very convex in both directions, high in middle, widest at posterior tooth, minutely pubescent. Regions defined, almost smooth. Front slightly produced and rounded, a small median notch. Compared to *N. texana sayi* (Smith) 1869, to which it is allied, the sides of the 3rd lateral tooth, (reckoning five teeth on a side), meet at an obtuse angle, in *sayi* at a right angle; the 4th and 5th teeth are right-angled, of *sayi* slightly acute. Dactylus of larger chela has a tooth at base of prehensile edge, in the female this tooth is greatly modified. Chelipeds minutely pubescent unequal and dissimilar. Carpus with a subdistal groove and a large inner tooth. Fingers dark brown with white tips, color running back from immovable finger on inside and outside of palm, continues a short way on palm, thence downward at right angle. Terminal segment of male abdomen subtriangular, not projecting sideways beyond penult segment; in *sayi* the terminal segment is shorter and wider, projecting sideways beyond penult segment. Legs long and slender.

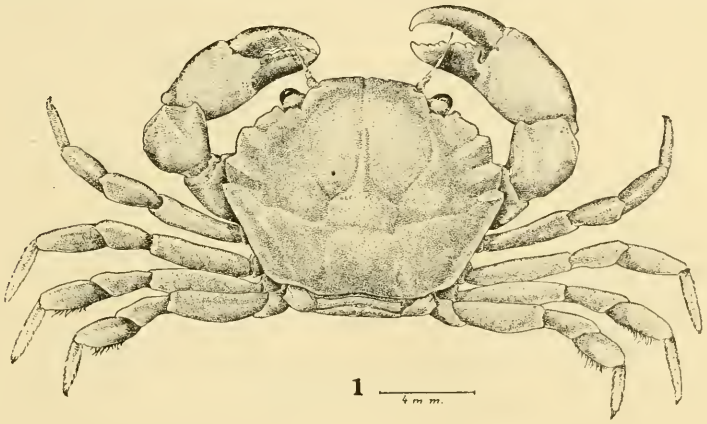
Color.—In preservatives: Carapace cream color mottled with bright red spots. Chelipeds brighter with numerous bright red blotches on outside of hand. Fingers deep dark brown, tips white. Ambulatory legs yellowish with a few scattered red spots. General appearance dull orange. Ventral side yellowish cream with a few scattered red spots. Maxillipeds with small red spots.

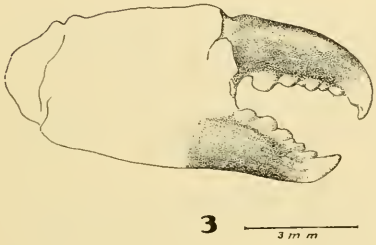
Measurements.—Holotype: Length of carapace 9.2 mm., width 11.8 mm. Paratype male (U. S. N. M. 67479): Length 10 mm., width 13 mm. Largest paratype male: Length 11 mm., width 15.2 mm.

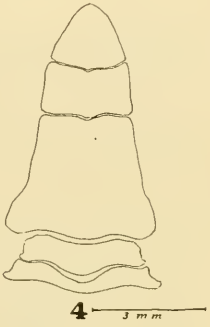
Material examined.—9 specimens from Puerto San Carlos, Sonora, Mexico.

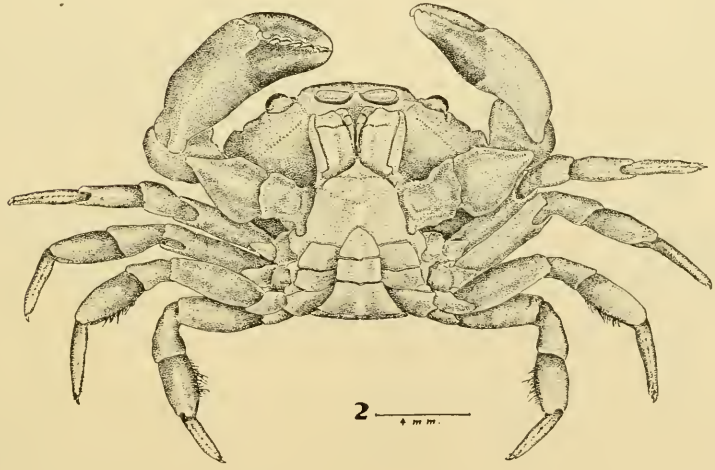
Remarks.—This species is subject to individual variation, as in the series of males taken, one specimen (the holotype) lacks the large tooth on the dactylus of the larger hand at base of prehensile edge. In another specimen the urogastric depression extends transversely across the mesobranchial regions.

This species is named for Mr. Anker Petersen of Beverly Hills, California, whose skill as an artist and devotion to detail have been an inspiration to me.









Neopanope peterseni Glassell, n. sp.

Fig. 1. Male holotype, dorsal view.
Fig. 2. Male holotype, large chela.
Fig. 3. Male holotype, abdomen.
Fig. 4. Male holotype, ventral view.

PINNOTHERIDAE

Fabia granti Glassell, n. sp.

Plate 26

Type.—Female, holotype; Cat. No. 67512, U. S. National Museum; Magdalena Bay, Lower California, Mexico, 7 fathoms, in worm tube; December 1, 1931; collected by Steve A. Glassell. Known only from type specimen.

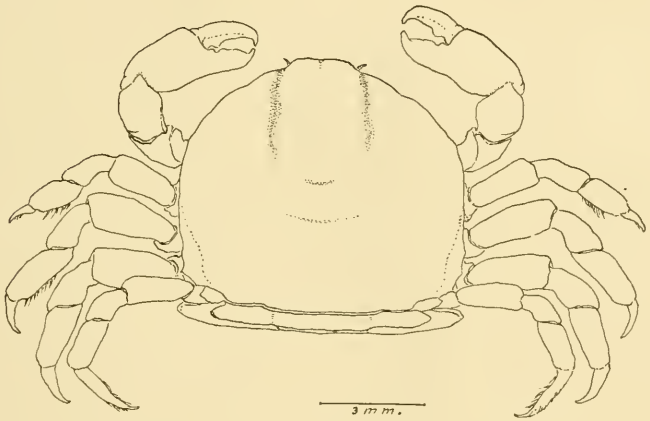
Diagnosis.—Female, without transverse sulcus on front. Palpus of outer maxilliped 2-jointed. Palm naked, widening distally. Dactyls of legs increasing in length from first to fourth.

Description.—Carapace thin and membranaceous. Anterior third with arcuate margin behind which the sides are for some distance subparallel. Margin acute especially along the front. Longitudinal sulci behind orbits well marked.

Corneae minute, black. A narrow, well marked furrow leading backward from the buccal angle. Palp of outer maxillipeds with only 2 articles, the customary terminal article absent. Chelipeds stout, equal; a small blunt tooth near upper end of merus; palm widening distally, thick; fingers not gaping but armed with a few low teeth, 2 near base of dactyl, 3 nearly covering edge of propodal finger; both fingers sharp, tips turned inward. Legs 2 and 3 of subequal length, 4 of similar shape but shorter, 1 is about the same length as 4 but narrower than all; dactyls curved, relative length 4 (longest), 3, 2, 1.

Measurements.—Holotype: Length 6 mm., width 7.5 mm.

This species is named for Dr. U. S. Grant, IV, of the University of California at Los Angeles, in appreciation of his many helpful suggestions and his encouragement to the author.



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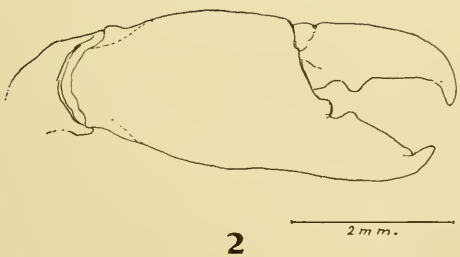

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3

Fabia granti Glassell, n. sp.

Fig. 1. Female holotype, dorsal view.
Fig. 2. Same specimen, right chela.
Fig. 3. Same specimen, outer maxilliped.
(Figure 3, x19, drawn by Dr. Waldo L. Schmitt, Curator, Div. of Marine Invertebrates, U. S. Nat. Museum)

28.898

TRANSACTIONS
OF THE
SAN DIEGO SOCIETY OF NATURAL HISTORY
VOL. VII, No. 29, pp. 345-346 NOVEMBER 22, 1933

THE TYPES OF THREE BIRDS DESCRIBED FROM CALIFORNIA

BY
A. J. VAN ROSSEM
California Institute of Technology

Dryobates homorus Cabanis and Heine, Mus. Heineanum, 4, ii, June, 1863 [1864], p. 65, footnote ("Californien").

Type.—No. B5162 [old cat.], 17169 [new cat.], Zoological Museum, University of Berlin; male adult, collected at Folsom, California, 1863, by Ferdinand Grüber; collector's number, 1434.

The type is a skin, taken down from mount and still retaining glass eyes and leg wires. The plumage is only very slightly abraded, which leads to the assumption that the bird was collected in late winter or, at the latest, in early spring. The label (not the original, however) bears the following inscription: 'Neue No. 17169 Alte No. B5162 "Male, Folsom, F. Grüber leg no. 1434" [the quotation marks evidently include the data from the original tag] Eingang Dec. 1863 [i. e. entered in the museum catalogue on that date] Gesammelt 1863 (Grüber in litt).' There is also a red type tag, evidently recently attached, which bears the name and citation of the original description. This type was examined by me on September 1, 1933.

The name *homorus* is, of course, a synonym of *Dryobates pubescens turati* (Malherbe) and no changes in current nomenclature are involved.

Cyanocitta superciliosa Strickland, Ann. and Mag. Nat. Hist., ser. 1, 15, 1845, p. 260 ("California").

Type.—1431a, Strickland Collection at the University of Cambridge; exact locality and collector unknown, [see also Salvin's Catalogue of the Strickland Collection].

This is a typical example of the northern interior race of the California Jay, which until now has been known as *Aphelocoma californica immanis* Grinnell. Thanks to the authorities at Cambridge, I was able to take this type to London and to compare it there with ample series of all the races. It agrees minutely with specimens from the Sacramento Valley. This type was examined by me on September 21 and 23, 1933.

Of the several tags attached, the one which is apparently the oldest reads,

"Callocitta superciliosa Strkd. californica. California, 1844. Obtained from Mr. Brandt." The date probably is the year of acquisition by Strickland rather than the year of the collection of the specimen.

Since this bird was obtained from Brandt it was most likely taken by one of the early Russian expeditions or traders which penetrated the interior from San Francisco. That it did come from the interior there can be no question, for it certainly is neither *californica* nor *oocleptica*, the two races about the Bay Region proper. It may be added that the skin is in good condition and in fresh, unabraded plumage.

The name of the interior race of the California Jay, the "Long-tailed Jay" of the 4th edition of the A. O .U. Check-List, therefore becomes *Aphelocoma californica superciliosa* (Strickland). In the absence of other data the type locality may be designated as the Sacramento Valley.

Passerculus alaudinus Bonaparte, Comptes rendus Acad. Sci. (Paris), 37, Dec., 1853, p. 918 ("Californie").

Type.—No. 1853-391, Mus. d'Hist. Naturelle, Paris; collected by P. A. Delattre [at San Francisco, probably in the summer of 1852].

The type is a mounted bird, unsexed, in worn mid- or late summer plumage. It is a partially albinistic example of the Bryant's Marsh Sparrow, normal in size and proportions and as regards the unaffected portions of the plumage. The albinism is in the form of small patches of white on the nape, back and rump; the streaking of the underparts is brown instead of brownish black and the yellow about the head is virtually absent. The measurements are: wing, 63.0; tail, 43.0; exposed culmen, 10.7; depth of bill at base, 6.0; middle toe minus claw, 13.1. The tarsi have been mutilated and cannot be measured accurately. On the bottom of the stand is written "Acquis a M. Delatre [sic], an de 1853 (Cat. No. 391) Californie." In a different hand is written "Passerculus alaudinus Bp. (Type)." This type was examined by me on July 22, 1933.

Reference to the catalogue shows that this specimen came to the museum with a small collection purchased from Delattre in 1853. It is one of the three small sparrows received at that time and listed simply as *"Emberiza."* One of the others is the type of *Haemophila ruficauda* Bonaparte; the third I was unable to trace.

Several name changes must follow as a result of the clearing up of the former uncertainty surrounding the identity of *alaudinus*. *Passerculus sandwichensis bryanti* Ridgway necessarily falls as a synonym of *alaudinus*, but further than this I withhold comment pending a forthcoming revision by Messrs. Peters and Griscom.

Unfortunately I was unable to locate either in the Paris Museum or at Leiden any specimen which could have been the type of Bonaparte's *Passerculus anthinus*. However, since the identity of *alaudinus* is now known, and since Bonaparte directly compared *anthinus* with *alaudinus*, the proper allocation of the former name would seem to present no great problem.

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NOTES ON SOME TYPES OF NORTH AMERICAN BIRDS

BY

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SAN DIEGO, CALIFORNIA

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Left: Type of *Crucirostra minor*. No. 6982, Berlin Museum.
Right: Type of *Loxia pusilla*. No. 6984, Berlin Museum.
(See page 359)

NOTES ON SOME TYPES OF NORTH AMERICAN BIRDS

BY

A. J. VAN ROSSEM

California Institute of Technology

During the summer of 1933 it was my privilege to visit various natural history museums in France, Germany, Holland, and England with the object of examining, critically, as many types of American birds as time allowed. While the time at my disposal was much too short to make more than a beginning, the method consistently followed was to pursue each individual case to the end, rather than to make a more general, and consequently superficial, survey of the field.

In a previous paper[1] I have discussed the types of three birds described from California. The present one deals with such as have a systematic bearing on species and subspecies within the more general scope of the A. O. U. Check-List, and further papers on Mexican and Central American birds will appear shortly.

Penelope vetula Wagler[2]

This very interesting type, which was once in the Monaco Museum is now in the Zoologische Sammlung des Bayerischen Staats in Munich. It carries no number, even though four tags of various ages are attached to the skin. The very meager data "Ortalida vetula Wagl. Mexico," and "Type of Penelope vetula Wagler" (this last in what I take to be Dr. Hellmayr's handwriting), provide the sum total of the information to be gleaned from labels. However, Wagler's description fits so well this peculiar specimen that there can be no reasonable doubt that it is his actual type specimen. I have not been able to find anywhere a chachalaca which approaches it in characters, and I fear that for the present the name *vetula* cannot be applied to any known geographic race of this species. The skin is not an artifact.

The body coloration is very much like that of the dark, richly colored race of southern Vera Cruz (*Ortalis vetula jalapensis* Miller and Griscom), in fact the bird might be called an extremely richly colored example of that race were it not for the pure white tail tips. These latter are, just as described by Wagler, snowy white. The outer pairs are somewhat dirty and grayish from wear, but the third from the outer pair is new and abruptly snow-white for the terminal 21 millimeters.

Whether this bird is a specimen of *jalapensis*, aberrant to the extent that the tail tipping is white instead of buff, or whether it belongs to a race whose range is,

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[1] Trans. San Diego Soc. Nat. Hist., 7, No. 29, Nov. 22, 1933.

[2] Isis von Oken, 23, 1830, Heft. xi, col. 1112 (Mexico).

as yet, unknown, it is not now possible to decide. Personally, I believe the former alternative to be the more likely, in which case *jalapensis* would become a synonym of *vetula*. At any rate the name can never apply to the northeastern subspecies which enters the United States in the Lower Rio Grande Valley, for the body coloration, even allowing for an impossible degree of post-mortem "foxing", at once eliminates the supposition that the type ever came from anywhere within the range of the race. Therefore, regardless of the final disposition of the name *vetula*, northern birds must again be known as *Ortalis vetula mccalli* Baird.

Empidonax ridgwayi Sclater[3]

Since both Ridgway and Hellmayr have expressed doubts concerning the status of this supposed species it is of interest to record that the type is a specimen of *Empidonax traillii traillii* (Audubon), normal save that the outer webs of the exterior rectrices are a little whiter than usual. The type in question is an unsexed skin, number 88.1.13.944 of the British Museum collection, collected at Bogota, Colombia, by Stevens (initials unknown) in 1855. In addition to the Sclater tag there is also attached a blank Smithsonian label, on the reverse of which appears in Ridgway's handwriting: "This is probably a new species. It is most like *traillii* in coloration but has the outer webs of exterior rectrices white, as in *obscurus*. R. R.". It is obvious, therefore, that Ridgway *had* examined this specimen, and had forgotten the circumstance at the time he wrote Part 4 of the 'Birds of North and Middle America'.

Muscicapa mesoleuca Lichtenstein

In 1830 Lichtenstein issued a price list of Mexican birds—the often quoted "Preis-Verzeichniss mexicanischer Vögel". This list, which has been criticized as a careless piece of work, was never intended as a scientific report. It was brought out simply to advertise for sale the birds collected by Deppe and Schiede on Deppe's first trip to Mexico. It was, just as it purported to be, a price list, and to criticize it on any other basis is patently unfair to Lichtenstein. Because of the nature of this list a great many of the names are pure *nomina nuda*, but in many instances a sketchy description is appended and such names have thus become available in the modern systematic sense. These descriptions (fide Dr. Stresemann) were intended to help possible purchasers to identify obscure or little known species, but that the sale was not overly successful is to be inferred from the fact that by far the greater part of the specimens listed are today still to be found in the mounted collection in the Zoological Museum in Berlin.

It may be appropriate to mention here that the citation as usually given is probably incorrect. The full title of the list as given by Cabanis in the January, 1863, issue of the Journal für Ornithologie is as follows:

Preis-Verzeichniss
der
Säugethiere, Vögel, Amphibien, Fische und Krebse, welche von

[3] Proc. Zool. Soc. Lond., 1887, 50 (Bogota, Colombia).

> den Herren Deppe und Schiede in Mexico gesammelt worden, und bei dem unterzeichneten Bevollmächtigten in Berlin gegen barre Zahlung in Preuss. Courant zu erhalten sind.

The title to Cabanis' reprint of the paper is "Lichtenstein's Preis-Verezeichniss mexicanischer Vögel etc." and it is this title which is invariably given as reference. The original both as to text and title may or may not be letter perfect with the reprint. Dr. Stresemann tells me that he does not know of a single copy in existence and it must be one of the rarest items in ornithological literature.

Among the flycatchers listed on page 2 of this list is "*Muscicapa mesoleuca* Licht. Graugrünlich mit weisslicher Kehle und dergl. Bauch". This name was first applied, in a purely speculative way, to the Olive-sided Flycatcher by Salvin and Godman in the 'Biologia Centrali-Americana' and a similar course was followed by Ridgway in Part 4 of 'Birds of North and Middle America'. Still later Hellmayr, in Part 5 of his 'Catalogue of Birds of the Americas', definitely fixed the name on the eastern race of the Olive-sided Flycatcher and designated number 2402 in the Berlin Museum as the type. This last procedure finds an echo in the 1931 edition of the A. O. U. Check-List, where the name of the species appears as *Nuttallornis mesoleucus* (Lichtenstein). That this is incorrect is evident from the following data.

By no stretch of imagination could an Olive-sided Flycatcher be described as "gray-greenish", and that Lichtenstein had an entirely different bird in hand is obvious, not only on the basis of the original description, but from the evidence supplied by specimens in the Berlin Museum.

Two Olive-sided Flycatchers (2402 and 2403) were taken by Deppe, and both are plainly inscribed "M. villica N. [obis]/Mas./Oaxaca. Gr. [af] v. [on] Sach. Deppe". In other words these two birds, which represent, respectively, the eastern and western races, are the types of Lichtenstein's *Myiarchus villicus*, a *nomen nudum* which first appeared in 1854 in the 'Nomenclator Avium Musei Zoologici Berolinensis', and was recited by Cabanis and Heine (Mus. Hein., 2, 1859, 72) as *Muscicapa villica* Licht., in the synonymy of *Contopus borealis*, the then current name of the Olive-sided Flycatcher! Someone, whose handwriting neither Dr. Stresemann nor I could identify, has tied, within relatively recent years, a red type tag to number 2402 and marked it as the type of *Muscicapa mesoleuca*, an entirely unjustifiable act since there is no indication that these two birds are other than the cotypes of *Myiarchus villicus*. It was undoubtedly this tag which misled Dr. Hellmayr.

Further search uncovered a South American flycatcher of the genus *Elaenea* which bore the old label "*M. mesoleuca* N [obis]/Montevideo 2506 Sello". This bird which *does* agree with Lichtenstein's description and which, furthermore, was in the Berlin Museum in Lichtenstein's time, and, as a final point, was originally catalogued as *Muscicapa mesoleuca*, is certainly the type. The name was obviously included in the Mexican list through oversight. The two Olive-sided Flycatchers are not included at all, but for that matter there are many other Deppe specimens which did not appear on the list. From the above data it is perfectly evident that neither Lichtenstein nor Cabanis, under whose direction

the older parts of the catalogue were prepared, ever associated Lichtenstein's *Muscicapa mesoleuca* with the Olive-sided Flycatcher.

Five years after Lichtenstein's 'Nomenclator' appeared, Cabanis and Heine (l. c. p. 60) redescribed the identical species of *Elaenea* under the name of *Elaenia mesoleuca*, basing their description on a specimen in the Heine Museum from Rio Grande [do Sul, southeastern Brazil]. Whether they really intended to describe a new species or simply used Lichtenstein's specific name in a new combination, is immaterial. The fact remains that their *Elaenia mesoleuca* is a strict synonym of *Muscicapa mesoleuca* Lichtenstein. The citation for this South American species should be corrected to read

Elaenea mesoleuca (Lichtenstein)

Muscicapa mesoleuca Lichtenstein, Preis-Verz. der . . . Vögel . . . , 1830, 2 (Mexico = Montevideo, Uruguay [and this latter locality is probably also in error]).

Tyrannus borealis Swainson

Swainson's type of this species is in the museum at Cambridge University, where I examined it on September 21, 1933. It is a skin in poor condition and the plumage is slightly, but definitely, "foxed" by post-mortem color change. The label bears the following inscription: "Female/Carlton/May 1827", and on the reverse appears: "Swainson/Tyrannula/Borealis/No. 53" [i.e. 35]. In common with most Cambridge skins this one bears no collection number.

Because of the fact that Swainson, in the original description, gives Cumberland House as the type locality, I thought at first that this individual, the only Olive-sided Flycatcher in the Swainson collection, might be a cotype. But since he specifically states that only one specimen, a female, was procured, it is evident that his designation was a *lapsus* and that Carlton House is the proper type locality.

The size of the type is that of the larger, western subspecies. Swainson's measurement of 4″ 4‴ for the wing is almost exactly the same as my own which is 109 millimeters. Therefore, the western race takes the name of

Nuttallornis borealis borealis (Swainson)

Tyrannus borealis Swainson, Fauna Boreali-Americana, 2, 1831 [Feb., 1832] 141 (Cumberland House = Carlton House, Saskatchewan, Canada).

For the eastern race the earliest name is

Nuttallornis borealis cooperi (Nuttall)

Muscicapa cooperi Nuttall, Man. Orn., U. S. and Canada, 1, 1832, 282 (Sweet Auburn = Mount Auburn, near Boston, Massachusetts).

Pyrocephalus mexicanus Sclater

Sclater's original description of *Pyrocephalus mexicanus* (Proc. Zool. Soc. Lond., 1859, 45) contained mention of Mexico, Texas, and New Mexico as being included in the range of the species. However, some years later, in his 'Catalogue of American Birds' he listed three specimens (all which he possessed),

a male from "Mexico" and a male and female from "N. Mexico", as the types of the species. Still later, in volume 11 of the 'Catalogue of Birds of the British Museum', he designated specimen "m" as the type, a proceeding which was scarcely permissible since he had previously stated that all three of his birds were types. In the British Museum today are all three of Sclater's birds, all marked as such, and since all are of the same race they must be regarded as cotypes.

Various ornithologists have long been aware that the Vermilion Flycatcher of California, Arizona, western New Mexico and south through Sonora to Nayarit was racially distinct from the form which occurs in eastern Mexico and Texas. Uncertainty as to which race was represented by the types of *mexicanus* has, until now, prevented the naming of the northwestern race, which may be known as

Pyrocephalus rubinus flammeus subsp. nov.

Type.—Male adult no. 8665, Dickey collection at the California Institute of Technology; Brawley, Imperial County, California, January 10, 1913; collected by A. J. van Rossem.

Subspecific characters.—Similar to *Pyrocephalus rubinus mexicanus* Sclater of eastern Mexico, but size slightly smaller; color of back, wings, and tail paler and more grayish (less blackish) slate; males with underparts averaging more orange (less crimson) red; females with the underparts less conspicuously streaked. Fifty fully adult males of *flammeus* measure: wing, 76-83 (80.4); tail, 57-61 (59.5), and 35 adult male *mexicanus* measure: wing, 82-87 (85.3); tail, 59-65 (63.7).

Range.—Southeastern California, southern Nevada, southwestern Utah, southern Arizona, southwestern New Mexico and south through Sonora to Nayarit.

Remarks.—Since specimens from southeastern Texas, Tamaulipas, and northern Vera Cruz exhibit the maximum development of the characters of *mexicanus*, Tampico, Tamaulipas, may appropriately be designated as a restricted type locality.

Corvus sinuatus Wagler

The original description of the Western Raven gave only "Mexico" for a type locality. Wagler's type specimen (number 1501) is in the Zoological Museum in Berlin, and was collected by Ferdinand Deppe at Ixmiquilpan. The only town of that name which I am able to find within the territory covered by Deppe on his first trip to Mexico is in the state of Hidalgo. The type locality of *Corvus corax sinuatus* is thus restricted to Ixmiquilpan, Hidalgo, Mexico.

In size the type is a little below the average for this race. It is marked as a male. The measurements are: wing, 418; tail, 242; exposed culmen, 75.0; depth of bill at nostrils, 27.0; tarsus, 74.5; middle toe minus claw, 49.0.

Tanagra auricollis Lichtenstein

Lichtenstein's four word description which follows this name on page 2 of the "Preis-Verzeichniss" is simply "Kehle und Brust goldgelb", and would be

quite worthless were his types not extant. The name has usually been quoted in the synonymy of *Icteria virens virens*, the eastern race of the Yellow-breasted Chat, though Bonaparte, in his 'Conspectus Generum Avium' distinguished *auricollis* from *viridis* (i.e. *virens*), and mentioned one of the minor characters of the western race.

In the Zoological Museum in Berlin are three specimens which were the basis of Lichtenstein's name and Bonaparte's subsequent comment. They are numbers 5880, 5881, and 5882, respectively, and were all collected at the City of Mexico by Ferdinand Deppe. To judge by their condition they were all collected in summer, and probably represent breeding birds. At any rate they are normal examples of the Long-tailed Chat, and Lawrence's *Icteria longicauda* necessarily must give way to the much earlier name.

The three specimens should probably be considered as cotypes, though someone at the Berlin Museum has attached a type tag to number 5182 as *the* type. This specimen is marked as "Mas", and has the following measurements: wing, 81; tail, 88; exposed culmen, 15.1; tarsus, 25.1; middle toe minus claw, 16.1.

Sylvia petasodes Lichtenstein

This name, which also originated in the "Preis-Verzeichniss", is very much of a composite, since the four specimens upon which it is based represent two, and possibly three, subspecies of Wilson's Warbler. Two of these birds are *pusilla*, one is *pileolata*, and one is so closely intermediate that it might represent either *pileolata* or *chryseola*. Someone at the Zoological Museum in Berlin, where these mounted specimens are preserved, has tied a type tag to number 4382 as *the* type. There is no means of knowing which bird Lichtenstein had in hand and since more than one subspecies is involved it is entirely proper to select a type. Therefore, I designate number 4382 as the type. By this action the name is safely buried as a synonym of *Wilsonia pusilla pusilla* (Wilson). This bird is a male, collected by Deppe, but unfortunately I overlooked recording the specific Mexican locality in which it was taken.

Psarocolius cyanocephalus Wagler

Though described simply as from "Mexico", the type, an adult male, was collected by Deppe at Temascaltepec, and it is now possible to restrict, accurately, the type locality. Because of the slightly abraded plumage, combined with a limited head and neck molt, I judge it to have been taken in early spring. The type of Brewer's Blackbird is a mounted specimen, number 7372 of the Zoological Museum in Berlin. Its measurements are: wing, 131; tail, 100.5; culmen from base, 23.3; depth of bill at base, 10.0; tarsus, 33.0; middle toe minus claw, 28.0.

Psarocolius aeneus Wagler

The name *aeneus* has long been in use, subspecifically, for the Bronzed Cowbird of northwestern Mexico and Arizona. This application is impossible from any standpoint, since Deppe, at the time the description was written, had never collected within several hundred miles of the range of the Bronzed Cowbird. Wagler's type and another male, also collected by Deppe, are in the mounted

collection at the Zoological Museum in Berlin. These were taken, respectively, at the City of Mexico and Lagunas. This latter locality is probably Laguna, a town between Vera Cruz and Alvarado, and not Lagunas in western Oaxaca. Deppe worked at both localities, but the Lagunas specimen is not the race (*assimilis* Nelson) found in western Oaxaca. However, this is not vitally important, since it is clearly the first-named specimen which Wagler used for his description and which is the type. In accordance with the original description the type has the rump mixed bronze and violet, but this condition is due to the circumstance that some of the rump feathers are missing, thus leaving the sub-basal portions of the remaining ones exposed. Except for this entirely fortuitous resemblance to the northwestern race, the bird is a normal Red-eyed Cowbird in size, coloration, and texture of plumage. The Red-eyed Cowbird of Texas, eastern Mexico, and Central America must take the name of *Tangavius aeneus aeneus* (Wagler). Both *Tangavius involucratus* Lesson, and *Molothrus robustus* Cabanis are synonyms of *aeneus*, and the Bronzed Cowbird is here re-described as

Tangavius aeneus milleri subsp. nov.

Type.—Female adult, no. 25595, Dickey collection at the California Institute of Technology; Tucson, Arizona, May 15, 1918; collected by H. H. Kimball, original number 2726.

Subspecific characters.—Adult males resemble the adult males of *Tangavius aeneus aeneus* (Wagler), but the rump is violet or mixed violet and bronze, instead of bronze concolor with the back and upper tailcoverts, and the anterior underparts are decidedly more bluish (less brassy) in tone; the texture of the plumage is smoother, and the size slightly larger. Females very different from the black females of *aeneus;* resembling in color the females of the generically distinct and very much smaller *Molothrus ater ater*, save that the females of *milleri* are more glossed with steely green on wings and tail and more purely gray as to the body plumage. Measurements of the type are: wing, 105; tail, 75; exposed culmen, 20.0; depth of bill at base, 12.0; tarsus, 27.5; middle toe minus claw, 21.5.

Range.—Southern Arizona (vicinity of Tucson), south through the Sonoran and Arid Tropical Zones of Sonora and Sinaloa to Nayarit.

Remarks.—In spite of the great color differences between females of *aeneus* on one hand, and the two western forms, *assimilis* and *milleri*, on the other, I believe that they should be treated as representative races rather than as separate species. It is admitted that the differences are absolute and the ranges are completely separated, so it is entirely a matter of opinion how they are treated systematically.

The northwestern race is named for Dr. Loye Holmes Miller, not only as a slight recognition of his abilities as an ornithologist, but in token of a twenty year friendship.

Cardinalis sinuatus Bonaparte

The type of *Cardinalis sinuatus* came to the British Museum in 1855 when the collection of the Zoological Society was sold. It is an adult male (No.

55.12.19.54), a skin in poor condition, and with most of the rump feathers missing. It evidently was at one time mounted. There are three tags attached, the oldest of which reads: "W. Mexico/Type" and on the reverse: "*Cardinalis sinuatus* No. 3". Next is a British Museum tag which bears a transcription of the same data, plus "Pres. by Zool. Soc.", and finally a type tag, on the reverse of which is the note, "Purchased at the sale of the Zoological Society".

The original description (Proc. Zool. Soc. Lond., 5, 1837, No. 59, [June 14, 1838], 111), had no more definite locality than "Western Parts of Mexico", but in 1850, in the Conspectus Avium, Bonaparte added "Zacatecas". However, such a restriction was more than likely because he had seen a skin of Wollweber origin in the Darmstadt Museum, and not because he obtained further data concerning the type. Zacatecas, though, will do well enough as a restricted type locality, since both the type and the Darmstadt skin are of the same race.

It is obvious that the type, while it may have come from "western Mexico" in a general geographic sense, was never taken on the Pacific coast, for it is a good example of the race now called *Pyrrhuloxia sinuata texana* Ridgway. Indeed I was able to match it with several specimens in a fine series in the British Museum from Duval County, Texas. It has nothing whatever to do with the paler, brown-toned race of Arizona and southward, which at present is called *sinuata.* An examination of nearly 300 Pyrrhuloxias in the collections of the British Museum, the California Institute of Technology, the Museum of Comparative Zoölogy, and the United States National Museum shows that the ranges currently ascribed to the two mainland races are in need of considerable adjustment.

Direct comparison discloses only the barest perceptible average difference between a series of eight specimens from Las Cruces, New Mexico, and large series from the Lower Rio Grande Valley in Texas and Mexico. I am well aware that the Arizona race is presumed to range east to Las Cruces and to El Paso, Texas, but it is difficult to find any authority for such a range extension other than current concept. The type of *Pyrrhuloxia sinuata beckhami* Ridgway, which was taken at El Paso, Texas, is in this same category. Though slightly browned by age it is certainly close (even in its present state) to the "*texana*" type. Modern skins from the same locality appear to be indistinguishable from Lower Rio Grande birds.

The fulvous-toned race of Arizona and southward apparently reaches its eastern and northern limits in the San Pedro and Santa Cruz River Valleys in the vicinity of Tucson. I know of no records to fill the 250 mile gap between Tucson and Las Cruces save for a single record from Camp Grant; nor are there likely to be any pyrrhuloxias, other than casuals, in this elevated and ecologically unsuitable stretch of plains. This western race, whose characters, in comparison with *sinuata*, are slightly smaller size, paler and more fulvous coloration, and a virtual absence of black intermixture in the red of the face and crest of the males is at present without a name. It may be known as *Pyrrhuloxia sinuata fulvescens* subsp. nov., with the type an adult female in fresh winter plumage, number C-570, Dickey collection at the California Institute of Technology; collected by Laurence M. Huey at Fort Lowell, Arizona, on December 27, 1915.

A summary of the rearrangement of nomenclature and ranges of the two continental races is as follows:

Pyrrhuloxia sinuata sinuata (Bonaparte)

Lower Austral Zone of southern and southeastern New Mexico, southeastward across Texas and south through Mexico to Puebla and Zacatecas.

Pyrrhuloxia sinuata fulvescens van Rossem

South-central Arizona, from the vicinity of Tucson south, through the Lower Sonoran and Arid Tropical Zones of Sonora, Sinaloa, western Durango and Nayarit.

These races occupy ranges which are apparently completely isolated one from the other, but distribution seems to be practically continuous within the range of each race. It is probably due to these circumstances that not only are the subspecific characters clean-cut, but that remarkably little variation occurs within each race.

Guiraca melanocephala Swainson

Since publishing a previous note (Auk, 49, 1932, 489) on the subspecific status of this very interesting type, I have had the opportunity to examine it personally at the University of Cambridge museum. The measurements are almost exactly as I formerly recorded them, save that I get an exposed culmen of 18.2 millimeters whereas Dr. Kinnear measured it as 16.5. This is due to a different method of taking this measurement, my own being to take, as a starting point, the edge of the skin which covers the culmen at a (usual) point somewhere between the base of the culmen and a line between the posterior edge of the nostril openings. This gives a slightly greater measurement than the conventional method of starting at the point where the feathers hide the culmen, but on the other hand it gives more uniform results, for such considerations as plumage wear and make of skin do not have to be allowed for.

Fringilla epopoae Lichtenstein

This name, the basis of which is a quartet of specimens collected by Deppe in southern Mexico, is a composite of the two recognized races of the Black-headed Grosbeak. An adult male and two females (one of which is marked as a male) are the larger, thick-billed *melanocephala,* and an adult male is the smaller *maculata.* Since there are two races involved in the type series and since it is not possible to decide which of the adult males was used in making the inadequate description, it is entirely proper to designate one as the type. Someone at the Zoological Museum in Berlin, where the types are preserved, has tied a type tag to number 6406. I concur in this selection and name adult male number 6406 as the restricted type. This renders *Fringilla epopoae* a harmless synonym of *Guiraca melanocephala* Swainson, and forestalls any attempt to resurrect the name for the small race, now,—and it is hoped permanently—known as *maculata* Audubon.

The restricted type, number 6406 of the Berlin Museum is an adult male

(from Jalapa) with the following measurements: wing, 105.0; tail, 81.5; exposed culmen, 18.7; depth, 15.3; tarsus, 24.1; middle toe minus claw, 16.5.

Fringilla xanthomaschalis Wagler

In the Zoologische Staatssammlung at Munich are the two cotypes, both adult males, of this name. They were both collected by Reerl and carry no more definite locality than Mexico. Though not extreme examples of the larger race of the Black-headed Grosbeak, they are certainly closer to it than to the smaller one. They have the following measurements: wing, 102-103; tail, 78-80; exposed culmen, 16.6-17.2; depth of bill at base, 14.7-15.0. *Fringilla xanthomaschalis* is therefore, like *Fringilla epopoae*, safely disposed of as a synonym of *Guiraca melanocephala* Swainson.

Loxia pusilla "Lcht." Gloger
Crucirostra minor "Licht." Brehm

In his diagnosis of the American red crossbills Gloger applied two names, "*Loxia pusilla* Lcht. und *Crucirostra americana* ? Wls.", as though he recognized, in a tentative way, that two forms were included in the series of four birds, two males and two females, which were in the Berlin Museum in Lichtenstein's time. These four specimens are numbered 6982, -3, -4, and -5, respectively, and do in fact represent two races. Two of them, 6982 and 6983, are of the very small-billed race of eastern North America, and these two are labelled somewhat differently from the others. Below the "Loxia americana, Bonap." of the upper line on the labels there also appears as a synonym, "Crucirostra americ. Wils.". This virtually settles the name *pusilla* on the two remaining specimens, numbers 6984 and 6985. Recently (Orn. Monats., 30, 1922, 41) Dr. Stresemann came to the same conclusion, insofar as the identity of the individual specimens which were the basis of Gloger's name is concerned, but he did not realize that two races were involved. However, as above stated, he was entirely correct in restricting the name *pusilla* and in designating number 6984 as the restricted type. Unfortunately a chain of nomenclatural upsets occurs as a result of the subspecific status of the type and cotype of *Loxia pusilla*. These two birds are not the small red crossbill, but are the race which was named by Bent, and which now appears in the 1931 edition of the A. O. U. Check-List, as *Loxia curvirostra percna*. The type of *pusilla*, which now replaces *percna* as the name of the larger crossbill of eastern North America, is an adult male which has the following measurements: wing, 90.5; tail, 54.0; exposed culmen, 18.8; depth of bill at base, 10.3; tarsus, 16.5; middle toe minus claw, 15.0. The female cotype gives: wing, 89.0; tail, 55.5; exposed culmen, 18.0; depth of bill at base, 10.0; tarsus, 17.0; middle toe minus claw, 13.6. The history of these two birds is that they came to the Berlin Museum in November, 1823, from C. H. Bescke, a dealer in Hamburg. They were collected by Bescke's son who, from time to time, sent his father bird skins from various eastern states, among which were New York, New Jersey, Virginia, Carolina, and Georgia. So far as I could determine these specimens were all originally labelled simply as "Nord-America", but from subsequent correspondence the states from which they (presumably) came were added. The two crossbills in

question were supposed to have been taken in Georgia, which may or may not be the case. At any rate the plumage abrasion is such that they were almost certainly taken in summer.

Since Brehm's *Crucirostra minor* is based on a Lichtenstein manuscript name one might argue with some justice that it is a synonym of *pusilla,* for either the name of *pusilla* or of *minor* is obviously an error on the part of someone. It is idle to speculate *which* name Lichtenstein intended to use, for, so far as I am aware, he never used either in print, and furthermore in 1854 (Nomen. Av. Mus. Zool. Berol., p. 48) he called the whole quartet *Loxia americana.* Though Gloger seems to have been skeptical about calling all four of the Berlin Museum red crossbills by one name there is no evidence that Brehm had similar ideas, unless one may infer as much by the fact that he picked a very small male as a model for his figure. The illustration which accompanies his revision of the crossbills in 'Naumannia' for 1853, so accurately depicts the bill of number 6982 that in all likelihood it was taken from that specimen. Since *minor* is a Lichtenstein manuscript name the basis must have been Berlin Museum specimens, and since Dr. Stresemann's action has eliminated the two larger birds from consideration, and since Brehm's figure matches exactly one of the smaller ones, it seems proper to designate adult male number 6982 as the type. It was collected in "Nord-America", by Schumann, but further data are lacking.

The accompanying illustration (Plate 27) shows the restricted type of *Crucirostra minor* on the left and the restricted type of *Loxia pusilla* on the right. Regardless of the position of the stands the bills of these birds are in exactly the same plane in respect to the camera. Unfortunately I completely forgot to record the measurements of *minor,* but this is partly compensated for by the photograph.

The nomenclature of the eastern red crossbills is corrected to stand as follows:

Loxia curvirostra minor (Brehm). Red Crossbill.

Crucirostra minor Brehm, Allg. deutsche Naturhist., Zeitung 1, 1846, 532, note (Eastern United States).

Loxia curvirostra pusilla Gloger. Newfoundland Crossbill.

Loxia pusilla "Lcht." Gloger, Vollst. Handb. Nat. Vögel Europas, 1834, 356 (America = Georgia).

Ammodramus bimaculatus Swainson

Swainson's type of this sparrow is still extant in the collection at Cambridge University. It bears an old (unnumbered) Swainson tag which reads: "Ammodramus bimaculatis [sic]/Sw./Bull/Mixico [sic]". The skin is fairly well preserved and the plumage is smoothed down, but, like most Bullock skins, is practically devoid of stuffing and pressed nearly flat. It is unsexed. The plumage is fresh, as though the bird had been taken not later than early winter.

This specimen does not represent the western Grasshopper Sparrow, but is of the small, dark-colored race, resident in southern Mexico, which was named by Nelson (Auk, 14, Jan., 1897, 61) as *Ammodramus savannarum obscurus.* The authorities at Cambridge very kindly allowed me to take the type to the

British Museum where there was ample material for proper subspecific determination, and where I was able to duplicate it with breeding specimens from Sola and Oaxaca City, Oaxaca, and Rio Blanco and Jitotal, Chiapas.

It is difficult to understand why the name *bimaculatus* was ever attached to the Western Grasshopper Sparrow, for Swainson's measurements definitely exclude that race from consideration. My own measurements are as follows, with Swainson's inches and fractions converted into millimeters in parentheses: wing, 54.5 (53.0); tail, 38.5 (38.0); exposed culmen, 12.3 (12.6); tarsus, 19.7; middle toe minus claw, 14.1. In my photostatic copy of the original description the fractional measurements of the tarsus and hind toe are blurred and cannot be read with certainty.

The necessary nomenclatural adjustments are, of course, that the name of *bimaculatus* must be transferred to the resident race of southern Mexico, and *obscurus* Nelson becomes a synonym of *bimaculatus*. For the Western Grasshopper Sparrow the oldest available name is *Ammodramus savannarum perpallidus* (Coues), the reference to which is [*Coturniculus passerinus*] var. *perpallidus* "Ridgway" Coues, Key No. Am. Birds, Oct., 1872, 137, in text ("dry western regions" = Antelope Island, Great Salt Lake, Utah).

Passerella hyperborea Bonaparte

My curiosity concerning the nomenclatural history of *Passerella hyperborea* was first aroused by a mounted fox sparrow in the Gallerie des Oiseaux in Paris, which bore the inscription, "*Passerella hyperborea* Bp./*Emberiza hyperborea* Pall.". Further data and a check in the catalogue showed this specimen to have been received in exchange from the "Museum of St. Petersburg" in 1846, and that it was collected on the northwest coast of America. It is a specimen of Townsend's Fox Sparrow, typical save that it has become reddened through age and exposure to about the color of a freshly-taken *meruloides*.

Some weeks later, in August, 1933, I found another Townsend's Fox Sparrow in the collection of the Zoological Museum in Berlin, which was labelled "*Passerella hyperborea* Pall/*Passerella Townsendi* Aud.", and which is a typical example of the race, taken by von Nordmann at Sitka.

Pallas' description of *Emberiza hyperborea* on page 35 of volume 2, of his 'Zoographica Rosso-Asiatica', is not only so vague as to be indeterminable but is based on a bird seen, but not collected, by Dr. Merk "*in terris Tschuktschicis*". While the description, "brown, below white, breast variegated with brown", might conceivably apply to a fox sparrow, it certainly does not unmistakably do so. The localities of other species which actually were collected by Merk and Billings are notoriously inaccurate—for instance the type of "*Passer arctuous* var. *gamma*" [= *Fringilla griseonucha* Brandt] is stated to have been taken on the Kurile Islands—and while there is every possibility that Dr. Merk's bird was a fox sparrow it was, if so, certainly not seen in eastern Asia, but on one of the Alaskan points touched by the expedition, such as Kodiak Island, where specimens are known to have been collected. At any rate it is evident that more than one European ornithologist, because of the name on labels attached to specimens

of *townsendi* received from Russian sources, believed the name *hyperborea* to apply to a dark brown fox sparrow. Why the Russians, or more likely Brandt, thought so might be explainable if there was a figure of the supposed species. Pallas' description was supposed to have been accompanied by a plate, for "Tab. XLIII. fig. 2" appears in connection with the name. But I have never seen such a plate in the more than a dozen copies of the work examined personally.

So much for *Emberiza hyperborea* Pallas. In the absence of an adequate description, a plate, or a type specimen, it may safely be disregarded as some sparrow which is unidentifiable, even generically.

Coming now to the second chapter. On page 477 of volume 1 of the 'Conspectus Generum Avium', Bonaparte, in 1850, included in his list of species in the genus *Passerella* the *Emberiza hyperborea* of Pallas, but based his description exclusively and explicitly on a specimen of "*Passerella hyperborea* Bp." in the Leiden Museum. Thus, though unintentionally, he created a valid name for some subspecies of fox sparrow. One of the chief objects of my visit to Leiden in early September, 1933, was to visit the Natural History Museum there and to examine this type, should it be still extant. Such, fortunately, proved to be the case. There are at present two fox sparrows at Leiden which bear the name *hyperborea*. Both are old mounted specimens with the ink of the handwritten labels faded to pale brown. Dr. van Oort is my authority for the statement that both were in the museum when Bonaparte was working there preparing the manuscript for his Conspectus. One of these birds is a Townsend's Fox Sparrow from "Sitcha", the other a typical specimen of "*insularis*" from "Ile Cadjak". It remains only to decide which of these birds Bonaparte had in hand when writing the description of *Passerella hyperborea* and this, fortunately, is easily determined. The diagnosis of "*rufo-brunnea; subtus alba, maculis latis rufo-brunneis: rostro conico, acuto*", definitely applies to the Kodiak Island specimen and not to the individual from Sitka. The latter is a dark bird with little or no red in the plumage and is striped medially as well as laterally. The Kodiak Island Fox Sparrow will, therefore, have to assume the name of *Passerella iliaca hyperborea* Bonaparte, and the name of *insularis* given by Ridgway fifty years later becomes a synonym of *hyperborea*.

The (unnumbered) Leiden specimen which now becomes the type of the Kodiak Island subspecies of fox sparrow is a female with the following measurements: wing, 83.5; tail, 75.0; exposed culmen, 13.3; depth of bill at base, 9.9; tarsus, 23.0; middle toe minus claw, 16.7.

It is indeed a curious circumstance that this valid name, proposed in an easily accessible and well known work, should have been so consistently ignored. Indeed, so far as I have been able to trace, it has never been quoted since its initial appearance in 1850, either in general works or, more strangely still, has it been mentioned by modern revisers of *Passerella*, all of whom seem to have absolutely ignored such elementary literature as the nomenclature employed by the first reviser.

TRANSACTIONS

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SAN DIEGO SOCIETY OF NATURAL HISTORY

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TWO NEW RACES OF THE BLACK CHACHALACA FROM CENTRAL AMERICA

BY

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In most museums the black chachalaca (*Penelopina nigra*) continues to be a rare bird and even in large collections is seldom represented by more than two or three specimens. Some years ago the writer, in the course of his El Salvador studies, had occasion to examine the material in American museums—ten skins in all—but at that time was so handicapped by the lack of females that the whole matter was shelved until such time as more specimens might become available.

In the limited series first examined, the single female from Nicaragua was markedly different in color from the single female from El Salvador and the two females from Guatemala. Between males from these three areas minor differences were observed, but here again no definite conclusions could be reached.

During the past summer I succeeded in locating two more Nicaragua females, one in the Museum d' Histoire Naturelle in Paris, and the other in the British Museum. Guatemala females are rare, but I have now seen eight, though only a few are definitely labelled as to locality. Males from all three areas, that is to say, Guatemala, El Salvador, and Nicaragua, are much more common than females. While this additional material permits of certain definite conclusions it by no means tells the whole story. For instance, Guatemala birds, because of insufficient label data in most cases, must be considered as a whole. Colors of soft parts are also of vital importance, though they have been recorded in very few instances. However, there are at least three races susceptible of definition and these

are characterized below. I must re-emphasize the fact that additional characters will probably come to light with the acquisition of carefully collected specimens.

Penelopina nigra nigra (Fraser)

Penelope niger Fraser, Proc. Zool. Soc. Lond., 1850, 246, pl. xxix (Hab.—? = Guatemala).

Subspecific characters.—Adult males with semi-nude area about eye purplish or bluish purple in life. Females distinctly sandy brown.

Range.—Humid Upper Tropical Zone (Subtropical Zone) of the mountains of Chiapas, Guatemala, and extreme southwestern El Salvador.

Remarks.—Fraser's plate and description call for a male with a bluish gloss, and the denuded circumocular area purplish blue in both sexes. Whether the female is so colored because of supposed similarity to the male or whether the author had reliable data is not known. In the case of the male the colors of the soft parts were undoubtedly taken from a live bird (mentioned by Fraser) which lived for "many years" in the aviary of Lord Derby. Moreover, the plate was made by Wolf while he was at the Derby Museum, according to Fraser's remarks in his introductory paragraph. Salvin and Godman record, in the 'Biologia Centrali-Americana,' that a greenish hued male from Santa Rita, Chiapas, had a purple circumocular area. Present evidence, then, is that the greenish hued males of the Pacific cordillera and the bluish hued males from Fraser's unknown type locality both have the area about the eye purple or purplish blue. Judging from such specimens as have definite locality data, it appears that greenish hued males are chiefly from the Pacific mountains and that bluish males are from the interior (I am speaking now of Guatemala), but the differences are not great and here, again, I am handicapped by the lack of accurately labelled females. At present it seems probable that two races occur in Guatemala and that the type locality of typical *nigra* will have to be restricted to the interior.

The single specimen, an adult male, from Volcan de Santa Ana in extreme southwestern El Salvador is placed here because of the pronounced greenish hue, and because of the analogy of the geographic affinities of many other species from that mountain. Unfortunately, I did not record the colors of the soft parts of this specimen.

Penelopina nigra dickeyi subsp. nov.

Type.—Male adult, no. 18439, Dickey collection at the California Institute of Technology; Los Esesmiles, Chalatenango, El Salvador, alt. 8000 ft., February 23, 1927; collected by A. J. van Rossem, original number, 11302.

Subspecific characters.—Adult males with semi-nude area about eye dull brownish red in life, with lower eyelid paler and more orange; plumage with a distinct bluish hue on upperparts and greenish only on outer webs of flight feathers. Females similar in plumage coloration to the females of *nigra;* area about eye "dusky" and lower eyelid dull pink.

Range.—Humid Upper Tropical Zone in the interior cordillera of El Salvador and at least the adjacent portions of Honduras.

Soft Parts.—In dried skins of all races the area about the eye is dull slate color and the colors of the soft parts must, therefore, be noted in the field to be of any diagnostic value. As a measure of comparison I give here the colors of all soft parts of *dickeyi*:

Adult male (*Type*). Iris, dark maroon red; bill, gular patch, wattle, tarsi, and feet, between orange-red and coral red; circumocular area, dull brownish red, with lower eyelid paler and more orange.

Adult (laying) female, no. 18469, Dickey collection; Los Esesmiles, February 26, 1927. Iris, reddish brown; tarsi and feet, dull brownish red; bill, dull brown; bare gular area, salmon pink; circumocular area, dusky, with lower eyelid dull pink.

Remarks.—Three males and one female of this race in the Dickey collection are the only specimens known. They were all taken at distances of less than a mile from the Honduras border and I saw others on the Honduras side of the line.

Penelopina nigra rufescens subsp. nov.

Type.—Female adult, no. 102676, American Museum of Natural History; Ocotál, Nicaragua, May 8, 1904; collected by W. B. Richardson.

Subspecific characters.—Adult males bluish, rather than greenish, in tone, and thus not distinguishable from *dickeyi* as dried skins. Females lighter and more reddish (less sandy) brown than either *nigra* or *dickeyi*, particularly on the upperparts, wings, and tail; light bars everywhere wider and dark bars correspondingly narrower. Colors of soft parts unknown.

Range.—Humid Upper Tropical Zone of the mountains of Nicaragua.

Remarks.—Additional characters will probably be apparent when the colors of the soft parts are known.

Measurements.—In the following table of measurement averages sex has been ignored, for there seems to be little or no size difference between males and females of any of the three races. For instance, both the largest and the smallest *rufescens* examined chance to be females and three of the seven males of *rufescens* are smaller than the two largest females. Immature birds are not included.

	Wing	*Tail*	*Exp. Culmen*	*Tarsus*	*Middle toe minus claw*
16 *nigra*	229	282	24.6	76.4	50.9
4 *dickeyi*	224	280	25.3	77.1	51.0
10 *rufescens*	217	267	22.8	76.4	50.6

Whether the apparently smaller size of *rufescens* would hold good in a larger series is questionable.

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TRANSACTIONS

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A NEW RACE OF PIRANGA BIDENTATA FROM CENTRAL AMERICA

BY

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The double-toothed tanagers of the whole great area from northeastern Mexico to Panama have heretofore been included under one name, *Piranga bidentata sanguinolenta* Lafresnaye. Why they have been so included I do not know, unless comparisons have been based exclusively on adult males. That Panama and Costa Rica birds of this species constitute a distinct race is abundantly demonstrated by females and young males which, instead of resembling *sanguinolenta,* have their closest color affinities with *Piranga bidentata bidentata* of western and southwestern Mexico. This race is described as

Piranga bidentata citrea subsp. nov.

Type.—Female adult, no. 31861, Dickey collection at the California Institute of Technology; Boquete, Chiriqui, Panama, September 14, 1901; collected by J. H. Batty.

Subspecific characters.—Adult males very similar to adult males of *Piranga bidentata sanguinolenta* Lafresnaye of eastern Mexico and northern Central America, and distinguished only in series by the more purely red sides and flanks, which, in *sanguinolenta,* are usually shaded with dusky green. Females and young males are very different from *sanguinolenta* in having lighter, brighter and more purely yellow underparts, and more yellowish (less olive) green upperparts. They resemble the females and young males of *Piranga bidentata bidentata* Swainson of western and southwestern Mexico but are brighter and richer yellow below and brighter and richer green above.

Range.—Highlands of western Panama and Costa Rica.

Remarks.—Many specimens have been examined from Veraguas north to

Volcan de Irazu in north central Costa Rica, but there seems to be little or no variation within this range. Similarly, series of *sanguinolenta* from northeastern Mexico, Vera Cruz, Guatemala, El Salvador, and northwestern Honduras appear to be inseparable save that adult males from the first-named area average slightly more greenish on the flanks and females from Central America are perhaps a trifle more deeply colored. If *citrea* intergrades with *sanguinolenta* at all, Nicaragua would be the probable area of contact, but, curiously, there appears to be a wide gap between the ranges.

Comparisons have been based on material in the collections at the American Museum of Natural History, the British Museum, the California Institute of Technology, the Museum of Comparative Zoölogy, and the United States National Museum.

28,898

TRANSACTIONS

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A NORTHWESTERN RACE OF THE VARIED BUNTING

BY

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A short time ago the writer commented on certain characters shown by a series of *Passerina versicolor* from Sonora.[1] At that time there were no females or young males available from Lower California and the Sonora specimens were accordingly referred, though with expressed doubts and solely on the basis of adult males, to *Passerina versicolor pulchra*. Since then a quantity of additional Sonora material and adequate series of both *versicolor* and *pulchra* has been studied, with the result that the breeding varied buntings of northwestern Mexico are seen to be a well-marked race. This is here named

Passerina versicolor dickeyae subsp. nov.

Type.—Female adult, no. 30463, Dickey collection at the California Institute of Technology; Chinobampo, southern Sonora, Mexico, February 10, 1930; collected by J. T. Wright, original no. 4997.

Subspecific characters.—Similar in size to *Passerina versicolor pulchra* Ridgway, of southern Lower California. Females and young males prevailingly rufescent brown instead of grayish brown (as in *versicolor*) or brownish gray (as in *pulchra*). Adult males very similar to adult males of *pulchra*, and distinguishable only in series by the greater extent and brighter hue of the red nuchal patch.

Range.—Breeds from north central Sonora and west central Chihuahua south on the Pacific slope of Mexico to Nayarit. Occurs (casually ?) in southeastern California, southern Arizona, and Jalisco.

Remarks.—Specimens from Nayarit (British Museum) are typical of this

[1] Trans. San Diego Soc. Nat. Hist., 6, No. 19, April, 1931, 293.

race, as is a single individual (Dec. 20) from Zapotlan, Jalisco. However, several others from Bolaños, Jalisco, are *versicolor*.

Like most buntings of this genus the present species wanders more or less widely from regular migration routes. The typical race, *versicolor*, of Mexico in general and southern Texas, has been reported as a casual from as far north as Michigan, and the Dickey collection contains a pair (male and female) which are typical in size and coloration, taken at Chinobampo, Sonora, on February 14 and 15, 1930. The Lower California *pulchra* occurs, in early spring at least, in apparently fair numbers on the mainland of Mexico, for we have four specimens taken at Chinobampo between March 2 and 9, 1930. I have examined, in the collection of the Los Angeles Museum, the two buntings (recorded as *pulchra*) taken at Blythe, Riverside County, California, on February 8 and 9, 1914. The female is *dickeyae* without question and the male is presumably that race also.

Considering the fact that three subspecies of the varied bunting occur in Sonora (though only one, of course breeds there) it is little wonder that Ridgway, on account of the variable character of western Mexico specimens, relegated his own race, *pulchra*, to the synonymy of *versicolor*. The key to the whole problem is, needless to say, the readily discernible characters of breeding birds.

In all, 59 specimens of *dickeyae* have been examined, the localities ranging from southeastern California south to Jalisco. Sonora records pretty well cover the Lower Sonoran and Arid Tropical Zones of the state, save for the Colorado Desert region in the extreme northwestern part.

This bunting is named for Mrs. Florence Dickey, not only because of her interest in western ornithology, but in appreciation of her kindness and assistance to me in innumerable ways.

28,898

TRANSACTIONS

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A SUBSPECIES OF THE BROWN TOWHEE FROM SOUTH-CENTRAL TEXAS

BY

A. J. VAN ROSSEM

California Institute of Technology

Last fall when looking through the Thayer collection at the Museum of Comparative Zoölogy in search of various Mexican birds, I was surprised to find a series of seven brown towhees from the vicinity of Kerrville, Texas, a locality far to the east of any recorded station for the species. Study of the material in the collection of the Bureau of Biological Survey has failed to disclose further specimens from this locality, or any which show the extreme characters of the Kerrville series, though most of the brown towhees from the Chisos Mountains, Davis Mountains, Alpine, Paisano, and other places in the section of Texas which lies directly south of New Mexico are more or less intermediate between *mesoleucus* and the Kerrville specimens. A single individual from the Pecos River, 55 miles northwest of Comstock, Valverde County, is certainly better placed with the Kerrville series than with *mesoleucus,* but the rest are so varyingly intermediate that larger series will be necessary in order to place them with certainty.

The central southern Texas race is named

Pipilo fuscus texanus subsp. nov.

Type.—Male adult, no. 16025, Thayer collection at the Museum of Comparative Zoölogy; Kerrville, Kerr County, Texas, April 24, 1910; collected by F. B. Armstrong.

Subspecific characters.—Most nearly resembles in color *Pipilo fuscus mesoleucus,* but darker and grayer; tail equal to wing instead of longer than wing.

Resembles *Pipilo fuscus potosinus* in size and relative proportions of wing and tail, but coloration paler and lacking the rich brown tones of that race.

Range.—Kerr County, west at least to Valverde County, Texas.

Measurements.—In the matter of comparative measurements, thirty male *mesoleucus* average: wing, 94.5; tail, 103.5, and in no single case is the tail shorter than the wing. Four male *texanus* measure: wing, 92-95 (93.3); tail, 90-93 (92.5). Three females measure: wing, 88-93 (91.0); tail, 89-95 (92.5).

My thanks are due to the Museum of Comparative Zoölogy for permission to describe this race and to the Bureau of Biological Survey for the privilege of examining their Texas series.

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TRANSACTIONS

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A NEW FORM OF POCKET GOPHER FROM SOUTHERN MONO COUNTY, CALIFORNIA

BY

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Curator of Birds and Mammals, San Diego Society of Natural History.

During field exploration for the San Diego Society of Natural History a series of gophers was collected in southern Mono County, California. The gophers from this region have been called *Thomomys quadratus fisheri* by several writers, but when compared with examples taken at the type locality of *fisheri* they show characters that warrant subspecific separation. A new race is therefore here described which may be known as

Thomomys quadratus monoensis subsp. nov.

Mono Pocket Gopher

Type.—From Dexter Creek Meadow, Mono County, California (more precisely, according to U. S. G. S. Topo. Sheet, Mt. Morrison Quadrangle, Kuhlee Ranch, at confluence of Dexter and Wet Creeks), altitude 6,800 feet; no. 10414, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, August 7, 1932.

Characters.—In color, *monoensis* differs from topotypical *fisheri* in more grayish tone on sides and more whitish underparts; dorsally the russet is more tawny than *fisheri*. Cranially, this form has more heavily developed molars, and a higher, more rounded brain case. This latter character is most evident when viewed anteriorly. In size, *monoensis* is larger than *fisheri*, the larger feet being easily apparent in the dried skins.

Measurements in Millimeters

	Total Length	Tail Vertebrae	Hind Foot	Ear	Greatest Length of Skull	Spread of Maxillary Arches	Length of Nasals	Interorbital Constriction	Alveolar Length of Upper Molar Series
T. q. monoensis (Type)	215	75	30	5.0	36.1	21.0	13.1	6.7	8.6
T. q. monoensis (Av. 6 ♀ Topotypes)	205	67	27	4.3	35.1	20.0	12.3	6.5	7.9
T. q. fisheri (Av. 4 ♀ Topotypes)	188	52	25	4.5	34.3	20.3	12.1	6.0	7.5

Range.—Recorded localities for the collection of gophers are many over Mono County, and no doubt all formerly listed as *fisheri* belong to this newly described form. However, only specimens from the type locality have been used in this description.

Specimens examined.—Thomomys quadratus fisheri:[1] 6 from Beckwith, Plumas County, California [type locality]; *Thomomys quadratus monoensis*: 17 from Dexter Creek Meadow, Mono County, California [type locality].

[1] From Dickey collection at the California Institute of Technology.

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TRANSACTIONS

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THE MAMMALS OF SOUTHERN NEVADA

BY

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California Institute of Technology

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THE MAMMALS OF SOUTHERN NEVADA

BY

WILLIAM HENRY BURT

California Institute of Technology

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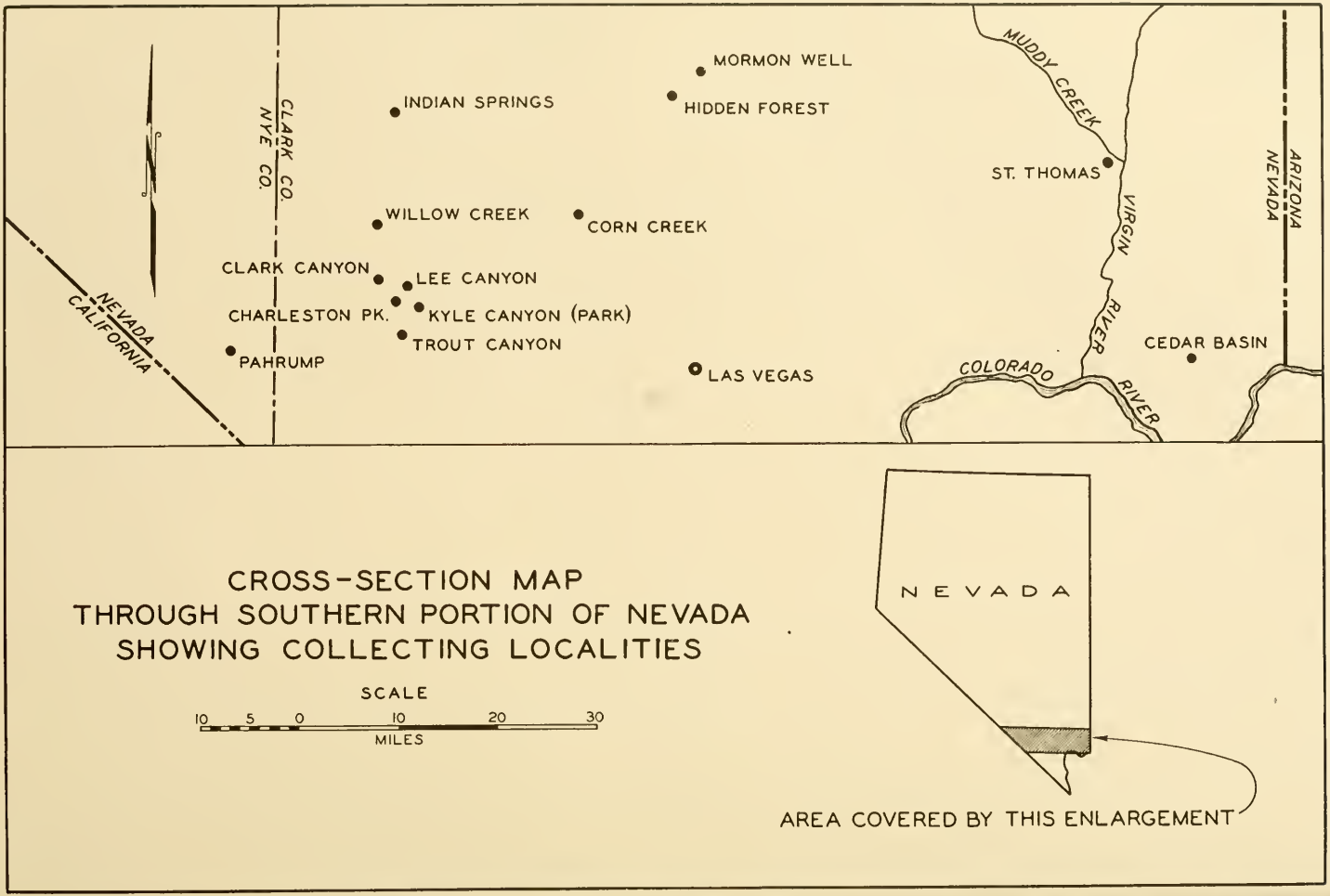
MORMON WELL
INDIAN SPRINGS
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NYE CO.
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CORN CREEK
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LEE CANYON
CHARLESTON PK.
KYLE CANYON (PARK)
TROUT CANYON
PAHRUMP
NEVADA
CALIFORNIA
LAS VEGAS
COLORADO
RIVER
CEDAR BASIN
CROSS-SECTION MAP
THROUGH SOUTHERN PORTION OF NEVADA
SHOWING COLLECTING LOCALITIES
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MILES
NEVADA
AREA COVERED BY THIS ENLARGEMENT

THE MAMMALS OF SOUTHERN NEVADA

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INTRODUCTION

The first collecting expedition of importance to enter southern Nevada was that of the Death Valley Expedition in 1891. Members of this expedition, studying both plant and animal life, visited chiefly the low-lying valleys, but also entered the less accessible Charleston Mountains which they penetrated from the west (Clark Canyon) to an altitude of 8,000 feet, and from the south (Mountain Spring) to an altitude of 5,500 feet. The results of the expedition, except for an account of the mammals which was never published as a unit, were published in North American Fauna No. 7, 1893. Subsequent to the Death Valley Expedition no intensive systematic mammal work had been done in southern Nevada until we entered the field in 1928, and the only published accounts of mammal species of the region are either descriptions of new forms or incidental mention of species in general reports.

The purpose of our work was to determine the species of mammal life inhabiting the region and to gather as much information as possible on the habits, local distribution, and ecology of the forms found there. Southern Nevada was selected for this study not only because of the limited knowledge of the mammals of the region, but because it afforded ideal conditions under which to study local distribution of forms inhabiting high arid mountains and the low deserts surrounding them; all of the plant belts (Life Zones) from the low creosote bush-mesquite association (Lower Sonoran) to timber line (Boreal) being represented.

From the standpoint of systematics and geographic distribution the work has proven worth while. Our collecting has brought to light four new races of mammals from the region (Burt, 1931 and 1933) and has thrown light on the questionable systematic status of other races previously described from there. Also a small addition to the meager knowledge of the natural history of many of our small mammals has been made.

The present account is based on field work conducted in southern Nevada from May 19 to August 7, 1928; from May 26 to August 9, 1929; and again from September 11 to 24, 1930. The author was assisted by Mr. T. E. Dawson from July 18 to August 7, 1928, and again from June 29 to August 9, 1929. From June 2 to 25, 1929, he was assisted by Mr. H. H. Sheldon. The two weeks in September, 1930, were spent to complete certain gaps not filled by the previous field work.

The area covered was roughly an east-west cross section of the state, thirty miles in width; the southernmost locality being at Las Vegas (latitude 36° 10′ north) and the northernmost at Mormon Well which is situated between the Sheep Range and the Las Vegas Range (latitude 36° 40′ north). In all 1366 specimens, constituting 56 species and subspecies of mammals, were taken during the two summers' field work. All of the specimens are now deposited in the Donald R. Dickey collection at the California Institute of Technology.

The writer is greatly indebted to the late Donald R. Dickey who, because of his keen interest in and lucid understanding of natural history, gave his whole-hearted support to the accumulation of data presented herein. Without his support the present project would not have been possible. I wish, also, to extend my sincere thanks to those who made our work more pleasant by the many courtesies extended us while we were in Nevada. Especially willing to help us were Mr. E. W. Griffith of Las Vegas who permitted us to carry on our work undisturbed in Kyle Canyon, of which he owns a large portion; Mr. and Mrs. Ira McFarland of Indian Springs who not only permitted us to camp at their ranch, but also took a keen interest in our work and helped us in many ways; and Mr. and Mrs. Tim Harnedy, also of Indian Springs, who gave us much information about the country and the condition of the roads, as well as extending us many courtesies. To Mr. W. L. McAtee of the United States Department of Agriculture, I am indebted for a report on cheek pouch contents which was made by Mr. C. C. Sperry of the Food Habits Research Department.

In the treatment of the species of mammals I have given the citations to the original descriptions only for those species or subspecies that have been described subsequent to Miller's List of North American Recent Mammals, 1923 (1924).

PHYSIOGRAPHY AND FAUNAL RELATIONS

It is not intended here to give a detailed account of the geological history of the region studied, but merely to enumerate certain features which probably have had a bearing upon the life found there today. For an account of the geology of the region the reader is referred to a paper by Dr. Longwell (1926).

The Charleston and Sheep ranges are relatively small mountain masses rising rather prominently from the low desert surrounding them. The Charleston Mountains (also known as the Spring Mountains) lie in a northwest-southeast direction, are about fifty miles in length and thirty miles in greatest width. They reach an altitude of nearly 12,000 feet on Charleston Peak, thus rising about 9,000 feet above the surrounding desert. The mountain masses contain many major thrust-faults and are rather precipitous; especially is this true on the east slopes where there are numerous rock exposures and vertical cliffs. Most of the water that falls as rain or snow soon finds its way beneath the surface and is the source of water for the artesian wells in the valleys. There are no meadows or lakes in the mountains. A few seepages and small springs are to be found and the melting snow feeds a number of small streams in the spring and early summer. These streams which run for relatively short distances constitute the chief water supply of the mountains. The higher reaches are well timbered in spite of the apparent aridity and dearth of soil in much of the area.

In the Sheep Range which lies in a northeast-southwest direction, nearly at right angles to the Charlestons, conditions are very similar to those depicted for the Charleston Mountains except that there is even less water and the altitude of the Charlestons is not reached by about 2,000 feet.

These two ranges which are separated by the Las Vegas Valley, a non-productive valley for the most part, are Boreal islands completely surrounded by great expanses of Lower Sonoran desert. As a consequence, a number of Boreal species of birds and mammals are found isolated in these two mountain ranges. That these mountains, though relatively small in area, have had an important bearing on the Boreal

species of bird and mammal life is shown by the fact that there are four races of birds (van Rossem, 1931) and six races of mammals which are, as now known, confined to these mountains. According to van Rossem (*ibid.*) the relationships of the bird species seem to be predominantly with Rocky Mountain forms. This relationship also exists with the plants of the region according to Jaeger (1926). The mammal species seem to have their affinities divided between eastern and western forms. Having eastern affinities are the three forms: *Callospermophilus lateralis certus, Eutamias dorsalis grinnelli,* and *Erethizon epixanthum couesi*; whereas *Sorex myops, Eutamias panamintinus juniperus,* and *Thomomys phelleoecus* have their nearest relatives in the mountains to the west. The other Boreal species are of a general distribution.

The assemblage of mammal species present on the low desert of course has not been affected by the small mountain ranges and represents a continuation of the mammal fauna found in the Colorado and Mohave deserts of California.

PLANT BELTS (LIFE ZONES)

It is the belief of the present writer that by the designation of "plant belts" (giving the most characteristic plants of each belt) rather than "Life Zones," as set forth by Merriam (1898), the reader will have a truer conception of the actual associational conditions prevailing in the area under consideration. The higher Life Zones, as interpreted from the plant life, are so poorly defined in this area that to speak of them as such while discussing mammal species might lead to confusion. Mammals, being warm-blooded, probably do not respond as readily to temperature changes and other external environmental influences as do plants, but instead are dependent upon certain species of plants, directly or indirectly, for food, shelter, etc. Food is the primary factor in the existence of any animal and consequently the distribution of animal species must be governed first by the available food supply and secondly by available shelter and breeding places, and possibly by other environmental influences such as mean temperature, humidity, etc.

The plant belts to be used in the present report with their corresponding Life Zones are given below. Although a small area on Charleston Peak is above timber line it is not considered here to represent the Arctic Alpine Zone, as it harbors no species of animal life which occur elsewhere in that zone. It is barren of tree growth by virtue of the fact that it is a rocky wind-swept peak.

PLANT BELTS	LIFE ZONES
Bristle-cone Pine (*Pinus aristata* Engelmann)	Hudsonian
Aspen (*Populus tremuloides aurea* Daniels)	
Fir (*Abies concolor* Lindl. & Gordon)	Canadian-Transition
Yellow Pine (*Pinus ponderosa scopulorum* Engelmann)	
Juniper (*Juniperus californica utahensis* Engelmann)	
Piñon Pine (*Pinus monophylla* Torrey & Fremont)	Upper Sonoran
Mohave Yucca (*Yucca mohavensis* Sargent)	
Mesquite (*Prosopis juliflora glandulosa* Torrey)	Lower Sonoran
Creosote Bush (*Larrea divaricata* Cavanille)	

The lower plant belts or zones extend relatively high in the mountains and the higher belts, from yellow pine to timber line, are crowded together. At an altitude of about 6,000 feet there is a fairly definite break between the Mohave Yucca and piñon pine-juniper associations, as indicated by the almost abrupt cessation of the Mohave Yucca and the sudden appearance of junipers and piñon pines.

Tongues of the piñon pine-juniper belt extend upward on the exposed ridges and in some instances, in the canyons, through the yellow pines and firs to an altitude of nearly 9,000 feet. In the bottoms of the canyons on the west exposure of the Sheep Mountains, piñon pines, junipers, yellow pines, aspens, firs, and bristle-cone pines are often seen side by side.

The peculiar situation concerning the distribution of plant life, that is the apparent mixing of the higher belts in the mountain ranges of southern Nevada, may be explained in part as follows: (1) the mountain ranges are small in area and isolated, thereby being influenced more directly by the surrounding desert than if they were larger in area (Grinnell and Swarth, 1913, p. 216); (2) they are surrounded by extensive desert regions, so that the warm ascending currents of air probably play an important part in elevating the positions of the lower belts (Merriam, 1899, p. 51); (3) the scarcity of water in the mountains and the extensive rock exposures and rocky slopes are conducive to warm conditions. In view of these facts it is not surprising to find the plant belts elevated in position and somewhat mixed.

As the slopes of the mountains are ascended the gradual decrease in the number of mammal species present is noticed. This is naturally to be expected because of the gradual decrease in area available for a species and the decrease in the number of different associations. The accompanying table, based on specimens collected, gives the number of species present in each of the plant belts represented, the number of spe-

cies confined, as far as collecting data show, to each of the belts, and the number of species occurring below and above each belt.

Table I. Showing Belts of Tree Growth in the Charleston Mountains with Number of Species Present, Confined To, Appearing Below, and Appearing Above Each Belt. Note Decrease in Number of Species Present from Left to Right of Table.

	Creosote Bush to Mohave Yucca	*Piñon Pine, Juniper*	*Yellow Pine, Fir, Aspen*	*Bristle-cone Pine*	*Above Timber line*
Number of species present	33	32	29	11	2
Number of species confined to belt	14	4	5	0	0
Number of species occurring in lower belts	0	18	21	11	2
Number of species occurring in higher belts	19	18	12	1	0

Habitats

In the following list of habitats an attempt is made to subdivide the area worked into environmental units each of which apparently has some influence upon the local distribution of one or more species of mammals. No attempt has been made at critical analyses of the different habitats to discern the specific influential factors within them. Consequently the terms used indicate only in a general way the type of habitat present, and the objects named are not necessarily the only, or even the important, factors in the part of the habitat concerned. If the entire vertebrate life of the region were being considered the following habitats could no doubt be subdivided into smaller units.

Small Canyon-Stream Habitat.—High up in the Charleston Mountains (8,000 feet altitude or over) were a few small streams running for short distances in the bottoms of the deep canyons. Some of these streams were fed, in part at least, by the melting snow; the water was cold and clear. Along their shallow banks in summer were narrow strips of small green vegetation and partially decayed logs were found at intervals in or near the water. It was in this type of habitat that the White Mountains Shrew was found. These streams also supplied drinking water for the deer and other mammals that required water. Most of the streams were running less than twenty-five inches of water.

Spring and Pond Habitat.—At Pahrump Ranch, Indian Springs, Corn Creek, and Las Vegas there is an abundance of water from springs and artesian wells. At Indian Springs and Corn Creek there were also man-made ponds fed by the springs. The luxuriant growth of vegetation about these springs and ponds served as food and shelter chiefly for harvest mice, cottontail rabbits, jack rabbits, pocket gophers (food), and bats. The insects about the vegetation served as food for hundreds of bats that flew over the ponds and about the trees every evening. Willows and cottonwoods, the dominant large trees about the springs, mark these as oases in the otherwise arid, hot desert.

River Habitat.—The low first bottoms along Virgin River and Muddy Creek, with their heavy growths of vegetation, harbor muskrats and Desert Pocket Mice—forms which are more or less confined to this type of association.

Sand Dune Habitat.—There are a number of small sand dunes scattered at intervals over the desert. They are usually covered with dense growths of mesquite which serve as excellent shelter and safety retreats for cottontail rabbits. Although cottontails were usually in the low vegetation surrounding the sand dunes, they invariably sought the dense covering of the dunes for safety. The Yuma Round-tailed Ground Squirrel and the Big Desert Kangaroo Rat were also closely associated with these sandy areas. The kangaroo rats particularly were confined to sandy areas where digging was relatively easy.

Low Desert Vegetation Habitat.—The most extensive habitat in the intermont valleys is that of the low desert vegetation consisting chiefly of creosote bush and sage brush. The Desert Kit Fox, Antelope Ground Squirrel, Merriam Kangaroo Rat, and Panamint Pocket Mouse are more or less restricted to this type of habitat. On the rocky slopes we found the Long-tailed Pocket Mouse to be common.

Brush Land Habitat.—Under this head I have included chaparral, oak, and mountain mahogany habitats. On the gentle mountain slopes, chiefly those that are south-facing, extensive areas of chaparral are found at altitudes ranging from 6,000 to 8,500 feet. The dominant chaparral plant is the manzanita, but in no place is it so dense that one cannot pass through with relative ease. The bottoms of the ravines and some of the benches have a fairly dense growth of oak or mountain mahogany. Deer, judging from our observations, occupy the brush land much of the time. None of the small mammals seem to be restricted to this area, although

white-footed mice and Desert Wood Rats are common around rocky situations.

Woodland Habitat.—This has been made an inclusive term covering the broad-leafed trees (willows, cottonwoods, and aspens) as well as the piñon pines and junipers. The willows and cottonwoods found around the springs on the desert have been discussed under the heading of *Spring and Pond Habitat.* The aspens, so far as we were able to determine, do not play an important part in the habitats of any of the mammals present.

The piñon pine and juniper habitat takes in a considerable part of the mountain area, forming dense forests in many places. Their fruits apparently make up an important part of the food of the Juniper Chipmunk in the Charlestown Mountains and of the Cliff Chipmunk in the Sheep and Virgin Mountains.

Forest Land Habitat.—The forest land habitat includes the higher parts of the Charleston and Sheep Mountains; the principal trees of this habitat are pines and firs. Restricted to the forest land habitat are: porcupines, Nevada Golden-mantled Ground Squirrels, and Palmer Chipmunks in the Charleston Mountains, and the Southern Nevada Chipmunk in the Sheep Mountains.

Rock Land Habitat.—In some of the lower regions of the mountains, especially at Cedar Basin in the Virgin Mountains, there are numerous boulders of considerable magnitude which serve as safety retreats for Rock Squirrels, Antelope Ground Squirrels, Cliff Chipmunks, Desert Wood Rats, Arizona Gray Foxes, and Desert Wildcats. The foxes and wildcats are common in these areas probably because of the abundance of available food. The local distribution of the Rock Squirrel in southern Nevada is apparently governed by this type of habitat.

Higher up in the mountains the numerous rock cliffs shelter the White Mountains Bushy-tailed Wood Rat and the True White-footed Mouse.

COLLECTING LOCALITIES

The following list of localities includes those at which we made our base camps. Work was usually conducted within a radius of two or three miles from each base camp. However, in some instances where it was possible to use the automobile for transportation the distance was extended to six or more miles. All possible associations were sought out and worked. The localities visited, with dates spent at each locality, are as follows:

The Lodge (Kyle Canyon).—The first camp was made at what is known locally as the Lodge, altitude 6,500 feet. This is near the lower edge of the piñon pine-juniper belt and at a place where the canyon widens out below into a large flat area with a deeper part of the canyon continuing along the south bank. A forest fire had passed through this part of the canyon in 1923 and most of the trees were killed, so that the dominant vegetation consisted of sage brush with cactus, yucca and many small plants in fewer numbers. The nearest water was a small spring over two miles up the canyon. About twenty acres had been cleared on the flat and an attempt was being made, but without much success, to farm this small area.

From this camp trapping was carried on up the canyon for about one-half mile and down the canyon to about the 4,000 foot contour. Trapping began May 27 and ended June 9, 1928.

Charleston Park Summer Resort.—The next camp, still in Kyle Canyon, was located at the summer resort at an altitude of 8,000 feet. This is the former site of an old saw mill and is near the upper edge of the yellow pine belt. Yellow pines and firs are the dominant trees in the bottom of the canyon and on the steep north-facing slope, except in the small draws where aspens are numerous. The south-facing slope is more gradual and is intervened by wide benches covered with dense growths of manzanita and mountain mahogany. A small spring on this slope furnishes water for the visitors at the resort. About one-half mile up a side canyon, on the south side, is a fair-sized stream that runs during the entire year. In late summer it carries about 20 inches of water. The stream comes over a high rock cliff and soon sinks below the surface; it is known locally as "Little Falls."

This was one of the localities at which the White Mountains Shrew was taken. Work was carried on at this camp from June 10 to 23, and from August 5 to 7, 1928.

Big Falls.—From the Charleston Park summer resort we packed in to an altitude of 10,000 feet; this was at the head of Kyle Canyon and at the base of Charleston Peak. Our camp was situated between the fir and bristle-cone pine belts. A small snow-fed stream was running over what is known locally as "Big Falls" on our arrival June 25, but within a week it failed to reach the falls, although it was still running a short distance above. There was a paucity of small vegetation here, but the slopes were well timbered with conifers. It was necessary to work the re-

maining 2,000 feet of the mountain on foot. The country was very rough; there were no trails and it was a hard journey of five hours from the camp to the top of Charleston Peak. Trap lines were run at intervals of about 500 feet altitude from the "Big Falls" camp to the top of the peak which is above timber line and nearly 12,000 feet above sea level. As previously stated, the decrease in the number of species of mammals present locally was noticeable as we proceeded to higher and higher elevations. The only species taken on the extreme peak was *Peromyscus maniculatus sonoriensis* (Le Conte) although on one occasion bats of an indeterminable species were seen flying over the peak after darkness had fallen.

Work was carried on between the "Big Falls" camp and Charleston Peak from June 25 to July 13, 1928.

Lee Canyon.—Lee Canyon lies to the north of Kyle Canyon on the east slope of the Charleston Mountains, and an automobile may be driven up to an altitude of about 8,500 feet. The conditions here were found to be essentially the same as those found at the summer resort in Kyle Canyon. Our camp was located near a small spring on the north side of the canyon. We worked here from July 1 to 5, 1929.

Willow Creek and Cold Creek.—Willow Creek and Cold Creek, the two largest streams that we encountered in the mountains, are on the north slope at an altitude of about 6,000 feet. They are approximately the same size; each carries about 55 inches of water and each has been stocked with small trout. They are located 16 miles south of Indian Springs, which in turn is at the north base of the range. Each stream appears suddenly from a low bank, Willow Creek running for about one-fourth mile and disappearing as suddenly as it starts; its shallow, moist banks are lined with willows, grasses, and other species of small vegetation. Cold Creek is located about three miles east of Willow Creek and is of the same general character. It was shunted off into an irrigation ditch which carried the water farther down to an abandoned ranch where the peculiar type of soil did not permit of prosperous farming.

Our camp was located midway between these two creeks at the lower edge of the piñon pine-juniper belt near a cabin owned by Mr. Clark, who was running about 1000 head of goats in the mountains. Our work here was confined to an area with a radius of about six miles and was carried on from July 18 to 31, 1928.

Las Vegas.—The base camp was made four miles northwest of Las Vegas, Nevada, near a ranch. Here we encountered the typical low des-

ert vegetation with quail brush, mesquite, and creosote bush predominating; altitude 2,100 feet. There was one artesian well near the ranch and three more a short distance away. The surrounding country was dry desert. A few small sand dunes which were covered with a dense growth of mesquite lay to the north and east of the ranch. The soil was a sandy clay with small rocks intermixed and after being soaked with water it dried into a hard substance much like adobe. We worked the surrounding territory for a radius of about four miles from May 26 to June 2, 1929.

Indian Springs.—Indian Springs is located at the north base of the Charleston Mountains at an altitude of 3,280 feet. A large spring at this locality supplies water for irrigation on the McFarland ranch. The spring carries 60 inches of water, the temperature of which, Mr. McFarland informed us, is about 78° Fahrenheit during all seasons of the year. The spring runs into a reservoir close by, which is surrounded by many large cottonwood trees.

To the south of Indian Springs are the foothills of the Charleston Range, and to the north is the junction of Indian Springs and Las Vegas valleys separating the Charleston Range from the low-lying Spotted and Pintwater ranges. There are a few small washes in the valley, but the general topography is fairly level. Igneous rocks of various sizes are found on the steep slope which leads up to the cliffs to the south of the spring. The lower land is generally sandy and the native vegetation is predominantly quail brush and creosote bush; Mohave Yucca makes its first appearance at about this level. In the ravines and near the water there are abundant growths of mesquite. Work was carried on here from July 31 to August 4, 1928, and again from June 2 to 8, 1929.

Pahrump Ranch.—Pahrump Ranch lies in Pahrump Valley to the west of the Charleston Range at an altitude of 2,667 feet. It is bountifully supplied with artesian water and the cultivated plants grow profusely in the sandy soil. The large trees about the ranch make it look like a veritable paradise when one is viewing it at a distance from the hot desert. The surrounding country is dry desert and is fairly level except for occasional washes which come down from the mountains. North and west of the ranch are some sand dunes which are covered with mesquite and quail brush, the latter making up the major part of the desert vegetation. Work was carried on here from June 10 to 12, 1929.

Trout Canyon.—Trout Canyon carries a small stream of water down the south slope of the Charleston Mountains. Our camp was made at

an altitude of 6,500 feet at the lower edge of the piñon pine-juniper belt. The country in general is rolling and rough, but not as precipitous as it is higher up in the mountains. We worked here from June 13 to 15, 1929.

Wheeler Well.—On the west slope of the Charleston Mountains, just below Wheeler Pass, where an old trail went through in the early days, is a small spring known as Wheeler Well. This, according to reports, was a stopping place for wagons to replenish their water supply. The old trail, still visible in some places, is mostly obliterated by the brush and small trees that have grown up and covered it. The altitude here was 6,600 feet and the low rolling hills were covered with piñon pines and junipers. In the small washes that led down from the hills were numerous smaller plants such as grasses, small flowering plants, and sage brush. We worked at this place from June 17 to 21, 1929.

Clark Canyon.—This deep canyon on the west slope of the Charleston Mountains is accessible by automobile up to about the 8,000 foot contour where are found the remains of an old saw mill. There is a small stream of water in the canyon above the saw mill site. The dominant trees are yellow pines with firs and aspens interspersed, while wild currants make up much of the undergrowth in the canyon bottom. The canyon was worked for a distance of a mile above and below camp from June 24 to 26, 1929.

Corn Creek.—Corn Creek Station is located 23 miles northwest of Las Vegas, in the middle of the Las Vegas Valley, at an altitude of 2,840 feet. It was a watering station during the time that the Las Vegas and Tonopah Railroad passed through that part of the country. The soil is a sandy alkali which forms a hard crust on top after it has been wet. The vegetation is chiefly creosote bush, quail brush, and mesquite. Work was carried on here from July 15 to 19, 1929.

Hidden Forest.—The Hidden Forest is in what is known locally as "Dead Man Canyon" on the west slope of the Sheep Mountains. We were able to drive up to an elevation of 8,500 feet where we made our camp. The only water we found was a small seepage on the north side of the canyon. The distribution of plants here is very peculiar, due possibly, in part at least, to the extreme aridity and the surrounding low deserts. The plants characteristic of the higher zones do not necessarily replace those characteristic of the lower zones as one passes up the slope, but the lower zone plants continue on up and intermingle with those of the higher zones. At an altitude of between 8,500 and 9,000 feet there

are, side by side, piñon pines, junipers, yellow pines, firs, aspens, and bristle-cone pines. The same mixture of plants was found in the Charleston Mountains, but there it was less evident. The topography of the country here was found to be about like that of the Charleston Mountains—very rough with precipitous rock cliffs on either side of the deep canyons. Work was carried on here from July 7 to 14, 1929.

Mormon Well.—Mormon Well lies almost due north of Las Vegas between the Las Vegas Range and the Sheep Range, altitude 6,500 feet. It is merely a shallow well dug in the bank with a pipe carrying the water out to a cement tank below. This was the only water we found in the region. The country about here is rolling, but not particularly rough; junipers and piñon pines are scattered throughout the hills and ravines. We were at this camp from July 20 to 26, 1929.

St. Thomas.—Our base camp here was one-half mile east of St. Thomas along the bank of Muddy Creek, about a mile above the junction of Muddy Creek and the Virgin River. The elevation was 1,250 feet. The vegetation was of the typical lower desert type with creosote bush, quail brush, and mesquite predominating. Much of the land is cleared and used for farming as the soil is sandy and suitable for agriculture wherever irrigation is possible. We worked here from July 28 to August 2, 1929.

Cedar Basin.—This is the site of a few old mine prospects at the south end of the Virgin Range. It is thirty miles by road southeast of St. Thomas. The country is fairly rough with numerous huge granite boulders scattered throughout. Junipers are the dominant trees with piñon pines and scrub oaks scattered among them. Work was carried on here from August 4 to 9, 1929.

LIST OF SPECIES

1. **Sorex myops** Merriam. White Mountains Dwarf Shrew.
2. **Macrotus californicus** Baird. California Leaf-nosed Bat.
3. **Myotis evotis chrysonotus** (J. A. Allen). Long-eared Bat.
4. **Myotis thysanodes thysanodes** Miller. Fringed Bat.
5. **Myotis volans interior** Miller. Interior Long-legged Bat.
6. **Myotis californicus pallidus** Stephens. Little Pallid Bat.
7. **Myotis subulatus melanorhinus** (Merriam). Black-nosed Bat.
8. **Lasionycteris noctivagans** (Le Conte). Silvery-haired Bat.
9. **Pipistrellus hesperus hesperus** (H. Allen). Western Bat.
10. **Eptesicus fuscus pallidus** Young. Pallid Brown Bat.
11. **Corynorhinus rafinesquii pallescens** Miller. Pale Lump-nosed Bat.

12. **Antrozous pallidus** (Le Conte). Desert Pallid Bat.
13. **Tadarida mexicana** (Saussure). Mexican Free-tailed Bat.
14. **Bassariscus astutus nevadensis** Miller. Cacomistle.
15. **Mustela** (sp.). Weasel.
16. **Spilogale gracilis gracilis** Merriam. Canyon Spotted Skunk.
17. **Mephitis mephitis major** (Howell). Great Basin Striped Skunk.
18. **Taxidea taxus berlandieri** Baird. Badger.
19. **Vulpes macrotis arsipus** Elliot. Desert Kit Fox.
20. **Urocyon cinereoargenteus scottii** Mearns. Arizona Gray Fox.
21. **Canis latrans estor** Merriam. Desert Coyote.
22. **Felis concolor** subspecies? Mountain Lion.
23. **Lynx rufus baileyi** Merriam. Desert Wildcat.
24. **Callospermophilus lateralis certus** Goldman. Nevada Golden-mantled Ground Squirrel.
25. **Citellus grammurus grammurus** (Say). Rock Squirrel.
26. **Citellus mollis stephensi** (Merriam). Stephens Soft-haired Ground Squirrel.
27. **Citellus tereticaudus tereticaudus** (Baird). Yuma Round-tailed Ground Squirrel.
28. **Ammospermophilus leucurus leucurus** (Merriam). Desert Antelope Ground Squirrel.
29. **Eutamias panamintinus juniperus** Burt. Juniper Chipmunk.
30. **Eutamias quadrivittatus nevadensis** Burt. Southern Nevada Chipmunk.
31. **Eutamias palmeri** Merriam. Palmer Chipmunk.
32. **Eutamias dorsalis utahensis** Merriam. Utah Cliff Chipmunk.
33. **Eutamias dorsalis grinnelli** Burt. Pallid Cliff Chipmunk.
34. **Thomomys bottae centralis** Hall. Valley Pocket Gopher.
35. **Thomomys phelleoecus** Burt. Sheep Mountains Pocket Gopher.
36. **Perognathus longimembris panamintinus** Merriam. Panamint Pocket Mouse.
37. **Perognathus parvus magruderensis** Osgood. Mt. Magruder Pocket Mouse.
38. **Perognathus formosus formosus** Merriam. Long-tailed Pocket Mouse.
39. **Perognathus penicillatus penicillatus** Woodhouse. Colorado Desert Pocket Mouse.
40. **Dipodomys merriami merriami** Mearns. Merriam Kangaroo Rat.
41. **Dipodomys microps levipes** (Merriam). Light-footed Kangaroo Rat.
42. **Dipodomys deserti deserti** Stephens. Big Desert Kangaroo Rat.
43. **Onychomys torridus longicaudus** Merriam. Long-tailed Grasshopper Mouse.
44. **Reithrodontomys megalotis megalotis** (Baird). Desert Harvest Mouse.
45. **Peromyscus crinitus stephensi** Mearns. Stephens Canyon Mouse.

46. **Peromyscus eremicus eremicus** (Baird). Desert White-footed Mouse.
47. **Peromyscus maniculatus sonoriensis** (Le Conte). Sonora White-footed Mouse.
48. **Peromyscus boylii rowleyi** (Allen). Rowley White-footed Mouse.
49. **Peromyscus truei truei** (Shufeldt). True White-footed Mouse.
50. **Neotoma lepida lepida** Thomas. Desert Wood Rat.
51. **Neotoma cinerea acraia** (Elliot). Mount Whitney Bushy-tailed Wood Rat.
52. **Ondatra zibethica bernardi** Goldman. Muskrat.
53. **Mus musculus musculus** Linnaeus. House Mouse.
54. **Erethizon epixanthum couesi** Mearns. Arizona Porcupine.
55. **Lepus californicus deserticola** Mearns. Desert Jack Rabbit.
56. **Sylvilagus nuttallii grangeri** (Allen). Black Hills Cottontail.
57. **Sylvilagus audubonii arizonae** (Allen). Arizona Cottontail.
58. **Odocoileus hemionus hemionus** (Rafinesque). Rocky Mountain Mule Deer.
59. **Ovis canadensis nelsoni** Merriam. Desert Bighorn.

General Account by Species

Sorex myops Merriam

White Mountains Dwarf Shrew

As far as known, this is the only shrew inhabiting the Charleston Mountains, where it is common along the small streams at altitudes of 8,000 feet or above. The following trapping records are significant in indicating the relative abundance of shrews in this region as compared with *Peromyscus maniculatus sonoriensis* (Le Conte). In 1928, during the seven days June 26 to July 2 inclusive, two hundred and seventy-five trap-nights in the bottom of a deep canyon at 10,000 feet altitude netted seven shrews and ninety-three *Peromyscus*. However, the relatively small number of shrews as compared with *Peromyscus* found in mammal collections indicates that the shrews are either much less abundant than *Peromyscus* or that they are more difficult to trap. Even assuming that shrews are as easily trapped as *Peromyscus* (although as a matter of fact they probably are not), the trapping records just given indicate that in this particular region shrews were at least one-twelfth as abundant along the canyon bottoms near streams or other water as were *Peromyscus*. Considering the great abundance of *Peromyscus*, shrews may be said to be fairly common in this locality.

Shrews were taken at three localities in the Charleston Mountains. In Kyle Canyon, on the east slope, they were taken at 8,000 feet and again at 10,000 feet altitude. On the west slope, in Clark Canyon, they were taken at 8,000 feet altitude. All of the specimens were taken in the bottoms of canyons and not farther than 300 yards from water. They were caught near decaying logs and along the bases of vertical cliffs in shaded, damp situations. These shrews are not wholly nocturnal, but are in part crepuscular in their habits. On the evening of August 5, 1928, after a string of mouse traps had been set along the small stream in the bottom of the canyon at Little Falls, I seated myself on a log which was about

thirty feet from one of the traps and awaited the appearance of bats. The trap was set on some fairly solid mud between two piles of debris that were about three feet apart. It was early dusk and as I chanced to glance at the spot where the trap was set I saw a shrew suddenly come out of the debris to one side of the mud flat and start across to the other side. Unfortunately for the shrew it went directly across the trap which was baited with oatmeal and a bit of bacon. The impression given was that the shrew had not been attracted to the bait, but rather that it was headed for the other pile of brush and chanced to cross the trap on its way. The shrew did not slow up until the trap was sprung and then it was caught across the back with its head over the edge of the trap.

This species of shrew has been known previously from two specimens only (Jackson, 1928, p. 174), both from the type locality, Pipers Creek (Cottonwood Creek), near main peak of White Mountains, altitude 9,500 feet, Mono County, California. During the summers of 1928 and 1929 we collected thirteen specimens in the Charleston Mountains. This not only extends the geographic range of the species, but adds to our knowledge of the diagnostic characters and the habitat in which it may be found. I have not personally examined the two specimens from the White Mountains, California, but Dr. Jackson, who was kind enough to compare the Charleston Mountains shrews with the type and one topotype of *myops,* concluded that there were no appreciable differences in the shrews from the two localities.

Because of the meager knowledge of the species it seems advisable, with the additional material at hand, to incorporate here the following list of measurements of the thirteen specimens collected.

MEASUREMENTS (IN MILLIMETERS) OF THIRTEEN SHREWS (*Sorex myops*) FROM THE CHARLESTON MOUNTAINS, NEVADA

Number	*Sex*	*Total Length*	*Tail Vertebrae*	*Hind Foot*	*Condylobasal Length of Skull*	*Palatal Length*	*Cranial Breadth*	*Interorbital Constriction*	*Maxillary Breadth*	*Maxillary Tooth Row*
14489	♂	94	40	11	15.1	6.1	7.2	3.2	4.1	5.7
14539	♂	91	37	10	15.0	5.9	6.9	2.9	4.1	5.4
14602	♂	89	41	11	.....	.....	.....	.....	.....	.....
14878	♂	94	41	11	.....	.....	7.0	.....	.....	.....
15746	♂	91	40	10	14.8	6.0	6.9	3.0	4.2	5.5
15759	♂	95	41	11	15.0	6.1	7.0	3.1	4.3	5.5
14488	♀	85	40	10	14.8	6.0	6.8	3.0	4.0	5.6
14512	♀	86	40	11	14.5	5.6	.....	3.0	4.1	5.5
14513	♀	87	40	10	14.5	5.7	6.9	3.0	4.1	5.4
14538	♀	90	36	11	15.2	6.0	.....	3.0	4.1	5.6
14544	♀	88	40	10	14.7	5.8	7.0	3.2	4.2	5.5
14603	♀	90	41	11	14.7	6.0	7.0	3.1	4.2	5.4
14890	♀	91	36	9	14.8	6.1	7.1	3.2	4.3	5.5

Macrotus californicus Baird
CALIFORNIA LEAF-NOSED BAT

Although over a hundred specimens of bats, consisting of twelve species, were collected during our two summers in Nevada, the only California Leaf-nosed Bats taken were mummified remains of individuals that had been killed during the winter of 1928 in an old mine tunnel. Our failure to collect any live ones was due either to their absence in the summer months or to the fact that they fly late after twilight has faded away (Stephens, 1906, p. 277). The latter alternative seems the more plausible.

Two high school boys of Las Vegas, Evan Wasden and Doyle Buhanan, informed me that during the Christmas holidays, December, 1928, they had killed about 120 bats in the "Frenchman's Mine," an old deserted mine seven miles east of Las Vegas, and that the bodies were still there. With the company of the two boys it was arranged to visit the mine May 31, 1928, in pursuit of more bats. The main tunnel of the mine extended straight back into the hillside for a distance of 540 yards (estimated by stepping it off). At this point it branched into a number of side tunnels; there was also a shaft which went down at an angle of nearly 90 degrees to the main tunnel for 160 ladder steps. This shaft then branched into some short horizontal tunnels. It was at the ends of these last small tunnels, in absolute darkness, that the boys had found the bats to be most numerous. Unfortunately, some previous visitors at the mine had built a fire at the point where the main entrance tunnel first branched and the smoke had permeated the farthest recesses of the mine. There was not a living bat to be found; if any were in the mine at the time the fire was built, they were evidently driven out by the smoke. However, on the floors of these deepest tunnels lay the mute evidence of the slaughter that had taken place during the previous winter. Dried bodies of bats lay everywhere, some in small piles where the boys had stopped to count the kill. Most of the dead bats were examined and they all proved to belong to the species *Macrotus californicus* Baird. About forty of the best specimens were picked up and saved.

On the same hillside, but somewhat higher than the main entrance to the big mine, is another tunnel that extends back into the mountain for a distance of 75 yards. In the extreme back of this tunnel we found two individuals belonging to the species *Corynorhinus rafinesquii pallescens* Miller (see page 397), but no *Macrotus*.

Stephens (*ibid.*) in speaking of this species (*Macrotus californicus*) says that he knows of no instance of its occurrence in California in winter, and H. W. Grinnell (1918, p. 257) states that she knows of no dates of capture within the state (California) later than September or earlier than March, save those furnished by Leo Wiley, this observer having taken (December 31, 1915) six individuals of this species in an old mine shaft near Palo Verde. A. B. Howell (1920, p. 173) states that in *Macrotus californicus* "the sexes have been found together only during the mating season. It is not a species that is strictly migratory, and may not be so at all, for a colony will spend the winter—apparently in a perfectly active state—in a deep cave, the temperature of which never varies greatly." Here in Nevada we have an instance of a large colony of bats of this species

occurring in an old mine tunnel in December, if the statement by the boys just referred to is correct as to date and there seems to be no question as to the truth of it.

Myotis evotis chrysonotus (J. A. Allen)
LONG-EARED BAT

This species was collected only in the yellow pine belt where it was found to be common at altitudes of 8,000 to 8,500 feet. Individuals were not observed to appear in the evening until late dusk and then they flew low among the trees. Their flight is erratic and they seldom appear above the sky line. An adult male collected June 24, 1929, had a half eaten moth in its mouth when shot.

As was suggested by H. W. Grinnell (1918, p. 297) this species probably breeds in the Transition Zone. A female, no. 15,750, collected June 24, 1929, contained a single embryo. An immature female, no. 14,873, was collected August 5, 1928. This indicates that the young are born in June or July.

Myotis thysanodes thysanodes Miller
FRINGED BAT

The Fringed Bat was taken at one locality only, near the Virgin River in a large salt cave six miles south of St. Thomas. When the cave was visited (July 31, 1929) we found the bats hanging from a rock in the zone of light intensity where the deep twilight was fading into darkness. None were found in the extreme darkness farther back in the cave. Sixteen individuals, nine males and seven females, were hanging in a single bunch; this bunch, about eight inches in diameter, had the superficial appearance of a bunch of bees hanging from the rock. Thirteen of the bats proved to be young of the year. Of the three adults (one male and two females) one female, no. 16,276, had the mammary glands slightly active. The mammary formula was $P\ ^{1}/_{1}=2$.

Other species of bats occupying the cave, but farther back in the extreme darkness, were *Eptesicus fuscus pallidus* Young, and a large-eared bat which, as nearly as could be determined from sight was either *Antrozous* or *Corynorhinus*. None of the latter were collected at the time.

Myotis volans interior Miller
INTERIOR LONG-LEGGED BAT

This is a common species in the yellow pine belt. Nine specimens were collected, all at altitudes from 8,000 to 10,000 feet in Kyle and Clark canyons and Hidden Forest. Usually they did not appear until late dusk at which time it was nearly too dark to collect them. For the most part they flew very low, not higher than fifteen to twenty feet, usually within ten feet of the ground. They were seen flying among the yellow pines and along the cliffs on either side of a small stream. Individuals often came down and hovered over a small pool of water. They were not observed to drink, but appeared to be catching small insects near the water's surface.

Myotis californicus pallidus Stephens
LITTLE PALLID BAT

A relatively common species, although not abundant, in the intermont valleys. One specimen, no. 16,259, was taken July 26, 1929, at an altitude of 6,500 feet which was well up into the piñon pine-juniper belt. Individuals of the species were usually not seen until late dusk. However, the specimen just referred to was taken at noon in the glaring sunlight. At this time our camp was at Mormon Well and the bat was seen flying about a cement water tank where some horses were watering. The bat caught a tarantula hawk (*Pepsis*) which was flying about the water and the two immediately came to the ground. The bat was squeaking and biting the tarantula hawk which in turn was clinging to the bat's face and applying the stinger to the top of its head. They had been fighting for three or four minutes when they were separated. The tarantula hawk flew away, but the bat was collected.

Lower down on the desert these bats were collected around clumps of bushes and trees near water at Indian Springs and Las Vegas. One bat, no. 15,580, was caught at night after it had entered a ranch house near Las Vegas. The flight of these bats is quite erratic and as was pointed out by Grinnell (1914, p. 266) they usually fly low among the bushes and seldom come above the sky line.

Myotis subulatus melanorhinus (Merriam)
BLACK-NOSED BAT

Only one specimen of this species was collected. This was an adult female, no. 15,873, collected July 10, 1929, at Hidden Forest, Sheep Mountains, at 8,500 feet altitude. It was shot at late dusk while flying among the yellow pines.

Lasionycteris noctivagans (Le Conte)
SILVERY-HAIRED BAT

An adult male specimen of this species was collected July 8, 1929, at Hidden Forest, Sheep Mountains, 8,500 feet altitude. This was the only one taken. It was well up in the yellow pine belt flying among the yellow pines and firs. When shot it was flying rapidly in a fairly straight line through an opening in the pines.

Pipistrellus hesperus hesperus (H. Allen)
WESTERN BAT

This was found to be the most common species of bat inhabiting the lower deserts of Nevada. However, it is not entirely confined to the low regions, as a specimen was collected at 8,500 feet altitude, in Hidden Forest, well up in the yellow pine belt. Specimens were also taken at Mormon Well and Kyle Canyon, both in the mountains. These bats were found most commonly near springs and water holes, but often individuals were seen flying out over the open desert several miles from water. In this case they usually flew near cliffs, and when flying over the open desert they were observed to fly much higher than they did when flying in the proximity of trees and water.

At Indian Springs these little bats were the first to make their appearance in the evenings. They came out from one-half to three-fourths of an hour before sundown and by dark the air was literally swarming with them. Because of their erratic flight we found them rather difficult to collect. While flying over a pond they were observed to dip down and touch the surface of the water as though they were drinking.

At Pahrump Ranch during the three days June 10 to 12, 1929, we found this species to be quite as abundant as it was at Indian Springs. Here at Pahrump Ranch individuals usually made their first appearance about one-half hour before sundown. On June 10, 1929, one of these bats was shot at 10 A. M. as it was flying about the barnyard in the glare of the bright sun.

During the daytime some of these bats hide in crevices in the cliffs, as was observed at Indian Springs where on August 3, 1928, a bat was taken from a small crevice in the rocks on the north side of a cliff. Another was seen, but not taken from the crevice.

A female, no. 14,269, collected May 31, 1928, contained two 9 mm. embryos. The young are born probably in June.

Eptesicus fuscus pallidus Young
Pallid Brown Bat

The Pallid Brown Bat was found commonly in the piñon pine and yellow pine belts. It was also seen, but less commonly, on the low desert floor. An adult male and female were taken at Indian Springs and Pahrump Ranch respectively and others were seen flying about the trees at late dusk. An immature female, no. 16,274, was taken July 31, 1929, in a salt cave six miles south of St. Thomas. An adult male was taken July 3, 1929, in Lee Canyon, altitude 8,200 feet. From July 7 to 13, 1929, eleven males were taken at Hidden Forest, altitude 8,500 feet. No females were taken at any time above the low creosote bush-mesquite belt whereas all of the males except one were taken in either piñon pine-juniper or yellow pine associations. This indicates the possibility of partial segregation of sexes after the breeding season.

These bats did not appear in the evenings until late dusk. When they first appeared they were observed to fly high over the tops of the trees, but as darkness came on they flew much lower, sometimes within two or three feet of the ground. Their flight is slow and moderately straight.

The series of sixteen bats of this species from southern Nevada shows a degree of pallor not found in bats from the Pacific Coast or from the eastern part of the United States. On the ventral surface the hairs are whitish or light buffy at the tips and on the dorsal surface of a number of the specimens the color is near the cinnamon-buff of Ridgway (1912). Allen (1933) states that certain extreme examples of *pallidus* are pinkish buff on the dorsal surface, but none of the specimens from southern Nevada show that degree of pallor. In series they are quite distinct from a series of *Eptesicus fuscus bernardinus* Rhoads from San Bernardino County, California. I quite agree with Dr. Allen (1933) in that the Pacific Coast race *bernardinus* and the race *pallidus* inhabiting the arid west-central part of the United States represent races which are distinguishable from the eastern United States race *fuscus*.

Corynorhinus rafinesquii pallescens Miller
PALE LUMP-NOSED BAT

On May 31, 1929, an old mine tunnel seven miles east of Las Vegas was examined for bats. The tunnel extended straight into a hill for a distance of 75 yards. At the extreme back, hanging together, were two bats of this species. When the light was cast upon them they became uneasy and soon took to flight; both of them were caught in a home-made net. After vacating the mine we started around the hill to look for another tunnel and were suddenly surprised to see one of the bats go flying off ahead of us. It was mid-afternoon and very warm, but the bat continued on around the hill and out of sight. It had escaped through a small hole in the sack, but the other bat, a male and the only specimen preserved, was made secure. According to H. W. Grinnell (1918, p. 343) *pallescens* normally inhabits caves or old mines.

The one specimen is not typical *pallescens*, but is somewhat darker than specimens from Imperial County, California, and has an accessory cusp on the inner upper incisor, a character present in *Corynorhinus rafinesquii mexicanus* G. M. Allen. The specimen at hand is probably grading toward *mexicanus*.

Antrozous pallidus (Le Conte)
DESERT PALLID BAT

During June and July we found this species to be a common inhabitant of the lower desert regions, especially around ranch houses at Indian Springs and Corn Creek where there was water and vegetation. They were most abundant at Indian Springs where they were seen in large numbers during the early part of June, 1929. However, the previous year (1928) when we visited the same place in August there were only a few of these bats to be seen; we saw two or three in an evening. Some of them had either migrated to some other place or were not active during this time.

Four adult females were collected at Indian Springs on the nights of June 2 and 7, 1929, but no males were taken at this time. Each of three of the females contained one well-developed embryo and the other female contained two 22 mm. embryos. Two of four specimens collected August 2 and 3, 1928, were immature. Three of the four were found suspended beneath an overhanging rock on the north side of a cliff at Indian Springs; the other was shot while flying low in an open space among some trees at Indian Springs.

During our stay at Indian Springs in August, 1928, Mrs. Ira McFarland, wife of the ranch owner, told us that earlier in the summer these bats would alight on the green lawn in front of their house and catch June Beetles. She said that they often came within a few feet of her while she was sitting on the lawn in the evenings, an observation which we also made during our second visit in June, 1929. These bats would fly low over the lawn and often alight on the ground in order to capture large June Beetles (*Polyphylla*). On the evening of June 7, 1929, as Mr. Sheldon was crossing the lawn he saw one of the bats apparently struggling with something on the ground. He walked toward the bat to pick it up, but when within ten feet of the spot the bat started to fly away. As Mr. Sheldon had his shotgun in his hand he collected the bat;

in its mouth was one of the beetles apparently uninjured. The beetle was later suspended from a branch of a tree by a long thread and a search light directed on it. As bats were flying about the lawn it was thought they might be attracted to the beetle, which would make it possible to collect more bats even though it was too dark to collect them otherwise. After about five minutes, a bat came by and seized the beetle; she was collected as she was struggling with it. Dr. Nelson (1918, p. 493) reports the capture of a bat of this species while it was taking a mole cricket (*Stenopalmatus fuscus*) from the ground.

These bats came out considerably later than the smaller species and apparently occupied a feeding zone which was much lower down than that of *Pipistrellus*. Their usual flight was from three to four feet above the ground, slow, and fairly straight.

The young are apparently born some time in June as the embryos in the females taken June 7, 1928, were nearly full term. Young bats nearly full grown were collected August 2 and 3, 1928.

Tadarida mexicana (Saussure)

Mexican Free-tailed Bat

This bat was found to be common on the desert. Specimens were taken at Las Vegas, Indian Springs, Pahrump Ranch, and St. Thomas. They made their first appearance in the evenings about one-half hour before sundown. They were observed to fly usually in a nearly straight line and at a much higher level than the other species here considered. Later in the evening, however, they occasionally came down to within fifteen or twenty feet of the ground. These bats were found to be most numerous at Pahrump Ranch where they were flying high over the open fields with swallows, swifts, and nighthawks. They occupied a zone in the air well above that occupied by most of the smaller *Pipistrellus*.

The young are probably born as late as July or August. A female taken at St. Thomas, July 28, 1929, contained one 30 mm. embryo. H. W. Grinnell (1918, p. 369) states that two females of this species taken June 7, 1915, each contained one large embryo, and that twelve females secured by Mr. Joseph Dixon between August 3 and 6, 1916, had their mammary glands full of milk.

Bassariscus astutus nevadensis Miller

Cacomistle

This species is reported by Miller (1913, p. 159) from Eldorado Canyon, Clark County, Nevada (type locality). We did not encounter it at any of the localities visited; it is possibly confined to the low hills along the Colorado River.

Mustela (sp.?)

Weasel

No weasels were collected and none were seen by myself, but reports from other individuals lead me to believe that it is not improbable that two species occur in the mountains. Mr. Morand, who was collecting butterflies in the Charleston Mountains, told me that he had seen weasels on two occasions. He

reported seeing a weasel near the stream at "Little Falls" and another at Willow Creek while sitting quietly awaiting the appearance of butterflies. Both of these were large weasels. Mr. Albert Curtis, who had spent several years in the Charleston Mountains and who impressed me as being a careful observer, gave me a description of what I interpreted to be a least weasel in the white winter pelage. Inasmuch as his description so perfectly fitted that of a least weasel and inasmuch as he did not know at the time that such an animal existed I considered it very probable that this is what he saw.

Spilogale gracilis gracilis Merriam
CANYON SPOTTED SKUNK

Two specimens of this species, a male and female, were taken on July 24 and 25, 1928, (6,000 feet altitude) at the lower limits of the piñon pine-juniper belt. They were caught in the same trap on two successive nights. The trap was set near a rock cliff about one-fourth mile east of Willow Creek, a small stream that comes out of the side of the mountain, and was baited with an old bobcat carcass. A third specimen was taken at St. Thomas September 23, 1930.

The provisional ranges of this subspecies and of *Spilogale gracilis saxatilis* Merriam were given by A. H. Howell (1906, pl. 1) as coming together in southern Nevada. The specimens at hand compare more closely with *gracilis* than they do with *saxatilis*.

Mephitis mephitis major (Howell)
GREAT BASIN STRIPED SKUNK

The Striped Skunk is apparently common along Muddy Creek and the Virgin River. Skunks were reported to be numerous near St. Thomas where we took two males and a female. We saw no signs of them at the other localities visited.

The southern Nevada skunk does not satisfactorily "fit in" with any previously described skunk, and it is with a great deal of hesitancy that I place it with *major*. Perhaps a larger series would show it to be of a distinct, unnamed race.

Taxidea taxus berlandieri Baird
BADGER

Badgers were taken on the low desert, in the piñon pine-juniper belt, and in the yellow pine belt, at altitudes ranging from 2,840 to 8,000 feet. They were common all through these three belts, but judging from their signs they were apparently more numerous on the desert than in the higher altitudes. Their large burrows were common even where the soil was quite rocky and where digging must have been difficult. The five specimens collected were all adult males. One of these, no. 14,841, was an extremely old individual, as shown by the well-worn teeth, although the skull is not prominently ridged as is the case in most old badgers.

Badgers belonging to the subspecies *berlandieri*, according to the original description (Baird, 1857, p. 205), have the white dorsal stripe extending to or nearly to the rump, being interrupted at intervals in many individuals. Four

of the specimens at hand agree in this respect with the original description, but in one specimen, no. 16,002, the white stripe is relatively narrower than it is in the others and ends just in front of the shoulders. The skull of this specimen agrees very closely with the skulls of the other individuals except that it is slightly larger. The skulls of badgers from southern Nevada differ from those from Arizona, northern Nevada, and California, that have been available for examination, in being somewhat smaller and in having the tooth row more crowded.

The skins of the specimens taken show the winter pelage, worn summer pelage, and in one specimen, the process of molting. The last specimen, no. 16,002, collected July 14, 1929, has the new short pelage on the head, throat, and the median portion of the back as far caudad as the hip region. The old worn pelage is still on the sides of the body, the rump, and the tail. The new hairs that were coming in are shorter and less numerous as one passes ventrad and caudad. The molt apparently begins on the dorsal part of the head, then passes caudad and ventrad in a fairly regular manner. The one specimen that still has the long winter pelage was taken in Kyle Canyon at 8,000 feet altitude June 16, 1928. A specimen taken at 4,500 feet altitude June 4, 1928, still has the old pelage, but it is badly worn. The time of molt is probably influenced in part by change of temperature, consequently the individuals on the low desert molt earlier in the summer than do those of the higher altitudes. Specimens taken at 7,200 feet altitude, above Willow Creek, July 30 and 31, 1928, had not commenced to molt. Badgers were also taken at Indian Springs and Corn Creek.

Vulpes macrotis arsipus Elliot

Desert Kit Fox

This species was common throughout the low desert region. At Corn Creek Station, altitude 2,840 feet, a female was caught July 16, 1929; her stomach was empty. Two days later (July 18) a male was caught; his stomach contained the ears of a cottontail rabbit (*Sylvilagus*), not bait, and the skins of two kangaroo rats (*Dipodomys*). The bones and meat had been completely dissolved by the gastric juices, but the skin, hair, and eyes of the kangaroo rats and the ears of the cottontail were undissolved. Both of the specimens were in the summer molt and had lost practically all of the winter coat except for small patches of hair on the neck and tail. The molt is apparently uneven over the body.

A third specimen in winter pelage was secured from a trapper; it is a male, collected December 24, 1929, at Indian Springs.

The Nevada specimens compare very closely with a series of five specimens from the vicinity of Fort Lowell, Pima County, Arizona. The males from Nevada average slightly smaller than the males from Arizona, but the females average about the same. They also agree very closely with the Arizona specimens in skull characters. Two specimens from Imperial County, California, are apparently the same as the Nevada specimens.

In the original description of *arsipus*, Elliot (1903, p. 256) gives the following under the heading of general characters: "Similar to *V. macrotis*, but

paler and smaller, post-orbital processes longer; pterygoid fossa narrower." A comparison of the measurements of *arsipus* as given by Elliot (*ibid.*) with those given by Merriam (1888, p. 137-138) in the original description of *Vulpes macrotis macrotis* shows only a slight difference in size, *arsipus* being on the average the larger of the two. The differences could fall well within the range of individual variation. However, the type of *macrotis* was a young adult male, so the measurements probably do not represent the average of the race. Unfortunately, no type was designated for *arsipus*.

An adult female *macrotis*, no. HX 27, from the neighborhood of Riverside County, California, averages about the same size as the Nevada and Arizona specimens, but differs from them in certain pertinent respects. The most obvious difference is in the shape of the nasals. In the Nevada specimens the nasals expand anteriorly, pinch in toward the middle, expand again posteriorly, then taper to a point that ends about even with the posterior borders of the premaxillae. In the California specimen the nasals taper gradually from the anterior to posterior ends, terminating in a point 4.5 mm. anterior to the posterior borders of the premaxillae. The lacrymal bone in *arsipus* from Nevada is prominently exposed on the anterior border of the orbit, whereas in *macrotis* only a very narrow rim is exposed. The size of the postorbital processes and the width of the pterygoid fossa as given by Elliot (*loc. cit.*) do not serve to distinguish the two subspecies one from the other. If anything, the pterygoid fossa is slightly wider in *arsipus* than in *macrotis*. Also the depth of the mandible posterior to M_3 is greater in *arsipus* than in *macrotis*.

Urocyon cinereoargenteus scottii Mearns
ARIZONA GRAY FOX

We found this species only in the piñon pine-juniper and yellow pine belts. It was most common in the piñon pine-juniper associations. Two males and two females were taken at Wheeler Well during the five days June 18 to 22 inclusive, 1929. The stomachs of all but one were empty. A female, no. 15,813, had the stomach full of rabbit, presumably the rabbit that was used for bait. A few fox tracks were seen at Lee Canyon and on the morning of July 1, 1929, a fox was seen making its way up the canyon. An adult male was trapped in Kyle Canyon February 5, 1931. Fox tracks were common in the snow at this time.

In the Hidden Forest, Sheep Mountains, we saw an occasional track of a fox and one specimen was trapped in the bottom of a canyon July 8, 1929. This was well up into the yellow pine belt. We again found signs of foxes at Cedar Basin where their tracks were numerous at the entrance to an old mine tunnel. Here they had a well-beaten path where they went in and out, apparently for the water that was standing in the mine about 50 feet from the entrance. Two foxes, a male and female, were trapped August 7, 1929, in sets about one-eighth mile apart. The stomach of the male contained part of a snake (*Coluber*). The male was caught some time during the forenoon after the traps were visited in the early morning. This trap was visited about 7:30 A. M. In the evening of the same day we again passed near the set and noticed that it had been disturbed. Upon closer examination we found a male fox in the trap;

it was dead and most of the viscera had been removed through a hole in one side of the abdominal wall. The fox had been caught probably in the forenoon after the traps had been run. The set was in the sun and the intense heat evidently caused the fox's death. The hole in its side was attributed to Turkey Vultures (*Cathartes aura septentrionalis* Wied), as they were quite numerous in that region; three of them were attracted to our bait and caught in our traps.

All of the foxes except the one taken in February were in badly worn summer pelage and had a ragged appearance.

Canis latrans estor Merriam
DESERT COYOTE

Coyotes were reported to be common throughout the desert and mountain regions. Tracks of coyotes were seen on the desert near Corn Creek Station, and they were also seen quite commonly in the piñon pine-juniper and yellow pine belts. A female was trapped at Wheeler Well, June 20, 1929, at a set where coyote tracks were seen on the previous day. Judging from their signs coyotes were quite common at Mormon Well. On the evening of July 26, 1929, we heard them howling all around us. We were unable to trap any at this locality, but in two instances their tracks were seen within ten feet of the sets; they were too wise to venture further. At Cedar Basin an old male coyote was caught on the evening of August 7, 1929. Although coyotes are supposed to be shrewd and hard to trap, this particular individual evidently was not. We passed the trap in the evening, about three-quarters of an hour before sundown and noticed that during the day the bait had been scattered and the trap partially exposed; it was covered again and the bait placed back of the set so that whatever reached the bait would pass over the trap. After re-making the set we continued on our way to string some mouse traps. At deep dusk we returned to our camp by way of the set that we had re-made and found an old male coyote in the trap. About one hour had elapsed between the time we re-made the set and our return. During this time the coyote had passed by the set and stepped into the trap. His stomach was empty.

Both specimens are in badly worn summer pelage. They agree essentially with *estor* in size, being smaller than either *Canis latrans lestes* Merriam or *Canis latrans ochropus* Eschscholtz. Compare the following cranial measurements of a male, no. 16 314, and a female, no. 15,809, with those given by Taylor (1911, p. 294): Basilar length of Hensel, ♂ 158.4, ♀ 154.6; zygomatic breadth, ♂ 94.8, ♀ 90.4; mastoid breadth, ♂ 56.5, ♀ 53.3; length of crown of upper carnassial, ♂ 20.6, ♀ 18.5.

Felis concolor subsp.?
MOUNTAIN LION

We saw no signs of Mountain Lions in the mountains, but were told by ranchers that a few had been seen there. I see no reason why they should not occur in the Charleston Mountains where deer are plentiful.

Lynx rufus baileyi Merriam
DESERT WILDCAT

Wildcats were common throughout southern Nevada, especially in the

mountains. They were taken at the following localities at altitudes ranging from 3,500 to 8,500 feet, from the Mohave Yucca belt to the yellow pine belt: Indian Springs, Cold Creek, Wheeler Well, Hidden Forest, and Cedar Basin. All of the specimens are in worn summer pelage. One specimen, no. 15,625, is somewhat paler and more grayish than the others which have very little gray in the upperparts. They are all sub-adults as shown by the skulls. A female collected July 19, 1928, was suckling young.

Wildcats do some of their prowling about in the daytime as was evidenced on July 7, 1929, when a young male was caught in early evening before sundown. The set had been made in the afternoon about two hours previous to the catch. Also on August 9, 1929, as we were leaving our camp at Cedar Basin in the late afternoon (4 P. M.), we saw a wildcat in the road ahead of us. When the cat saw us it galloped awkwardly up a steep slope that was covered with low brush.

Callospermophilus lateralis certus Goldman

NEVADA GOLDEN-MANTLED GROUND SQUIRREL

This species is second only to the chipmunk (*Eutamias palmeri* Merriam), in the Charleston Mountains, in being the most conspicuous mammal of the forested region. It is apparently confined to the Charleston Mountains, where its vertical range is from about the middle of the piñon pine-juniper belt to timber line.

We found this species to be most abundant at the Charleston Park summer resort, where individuals were quite accustomed to the people and could be approached without difficulty. At our camp higher up in the mountains (10,000 feet altitude), these little fellows became familiar within a week's time and came down around the camp in search of food that had been thrown out. At Wheeler Well an adult male rummaged through our trash heap nearly every day for tidbits. On June 20, 1929, he was seen taking a fairly large piece of bacon rind away. A Woodhouse Jay which had also been getting tidbits pursued him, but this did not seem to bother the squirrel.

This golden-mantled ground squirrel is wholly a ground dweller as far as our observations show. Holes inhabited by the squirrels were found in banks, along washes, at bases of trees, under boulders, and, at the Charleston Park summer resort, beneath cabins and rock piles.

The young are probably born in early June. Females collected from June 11 to July 11 were suckling young and young squirrels about one-fourth grown were seen during the middle of June; one was collected June 16, 1928. We have no data on the number of young in a litter, but it is probably not so different from the number in other species of this genus. For the species *Callospermophilus chrysodeirus chrysodeirus* (Merriam) Grinnell and Storer (1924, p. 176) state that "Females containing embryos were taken in 1915 on June 12 (two on this date), 14, 26, and 28, the numbers of embryos in these instances being 2, 5, 6, 6, and 5, respectively." *C. l. certus*, a more southern form, evidently breeds somewhat earlier than *chrysodeirus*. As far as our data show, no females collected on June 11 or later contained embryos, but many of them were suckling young. The mammary formula is $P\ ^{2}/_{2}$, $A\ ^{1}/_{1}$, $I\ ^{2}/_{2} = 10$.

Apparently there is but one annual molt which occurs in June or July, the time of molt being slightly later at the higher altitudes. A specimen, no. 15,698, collected June 17, 1929, at 6,600 feet altitude has its new pelage except for a small area on the rump and tail. Specimens taken at 8,000 feet altitude June 21, 1928, are slightly over half molted, and a specimen, no. 14,590, collected July 6, 1928, at 11,800 feet altitude has scarcely commenced to molt. A specimen, no. 14,876, collected August 7, 1928, at 8,000 feet altitude is completely molted. In the old worn pelage, which is much paler than the new pelage, the black lateral stripes have faded to very pale, almost brownish, stripes. The copper-colored head is also much paler than in the new pelage.

The molt is fairly even; it begins on the nose and head, then progresses caudad and ventrad in a fairly definite manner. It progresses more rapidly in the mid-dorsal region so that if the skin is stretched out flat the line of molt forms a distinct "V" with the open portion directed cephalad.

Citellus grammurus grammurus (Say)

Rock Squirrel

This species was found to be common in the piñon pine-juniper belt below which it was not seen. Specimens were also taken in the yellow pine belt, altitude 8,500 feet. Their local range is apparently governed by the presence or absence of safety retreats, as we found them only where there were large boulders or their equivalents. In the Charleston Mountains, Rock Squirrels were found to be most common between 6,000 and 6,500 feet altitude. They were numerous around an old saw mill in Kyle Canyon (altitude 7,000 feet) where they sought safety beneath a large pile of lumber. Also near Willow Creek we found these squirrels common where large boulders served as safety retreats. The squirrels were most numerous, however, at Cedar Basin where they made their burrows beneath the numerous large granite boulders. They also used these boulders as lookout posts, often sitting erect, "picket pin" fashion, on top of them. The color of the squirrels blended so perfectly with the color of the rocks that it was difficult to distinguish them unless the squirrels chanced to move. When danger was sensed by a squirrel he would utter his shrill whistle-like notes, whereupon all Rock Squirrels in the immediate vicinity would take to cover. We found them very shy and difficult to approach.

A female, no. 14,164, collected May 23, 1928, had the cheek pouches filled with small pieces of roots and one green leaf. One female collected May 26, 1928, was suckling young, but no young squirrels were seen during this time. In 1928 young squirrels slightly over half-grown were collected on June 29 and July 24 to 26 inclusive. In 1929 half-grown Rock Squirrels were collected on August 4. The young are apparently born in May and June over this part of their range. Although herbivorous, these squirrels apparently have a fondness for meat, as shown by the fact that six of the sixteen specimens collected were caught at sets baited with meat. The other ten were either shot or caught in rat traps with rolled oats as bait.

We made a second visit to Cedar Basin on September 23, 1930, and at this time no Rock Squirrels were in evidence. They had apparently gone into hibernation.

Citellus mollis stephensi (Merriam)

STEPHENS SOFT-HAIRED GROUND SQUIRREL

This is apparently a rare species in southern Nevada. Although we continually had traps out for ground squirrels, we caught but one specimen, an immature male, collected June 4, 1929, at Indian Springs. Their seeming absence could hardly be due to "holing up" so early in the season. The specimen collected was on the desert floor, altitude 3,280 feet. In California this species ranges chiefly in the Upper Sonoran Zone, barely entering Transition locally (Grinnell and Dixon, 1918, p. 666). In a series of specimens in the Dickey collection from Nye and Esmeralda Counties, Nevada, none were taken at an altitude below 4,100 feet; most of the specimens being taken between 5,000 and 7,000 feet altitude. It would seem that their occurrence low down on the desert is normally not to be expected.

Their absence higher up in the Charleston Mountains is possibly explainable, in part at least, by the fact that environmental conditions are not suitable for this species. The type of soil is generally rocky and there are no sandy conditions that would be favorable for the existence of the species. At Indian Springs, where the one specimen was taken, the soil is of a sandy nature and the vegetation is chiefly quail brush and mesquite.

Citellus tereticaudus tereticaudus (Baird)

YUMA ROUND-TAILED GROUND SQUIRREL

This species was found only low down on the desert in creosote bush-mesquite association. An immature female was caught June 1, 1929, near a sand dune four miles northwest of Las Vegas. The trap was set under a small bush near a bunch of mesquite. Later, on the same day, two of these squirrels were seen attempting to cross the highway at the west limits of Las Vegas.

We again encountered this species near St. Thomas among the sand dunes that lay along the banks of Muddy Creek. Two individuals were caught July 31, 1929, these being the only ones seen.

The specimen taken near Las Vegas June 1, 1929, was in the process of molting. The new pelage had replaced the old on the head and rump, but a wide band of the old coat still remained just back of the ears. The other specimens were completely molted.

Ammospermophilus leucurus leucurus (Merriam)

DESERT ANTELOPE GROUND SQUIRREL

This species was found to be common on the low desert and in the piñon pine-juniper belt. It was also found, but not commonly, in the yellow pine belt at 8,500 feet altitude. It is distributed generally throughout the lower regions of this area, but the numbers of individuals vary somewhat locally. Antelope Ground Squirrels were found at higher altitudes on the west slopes than they were on the east or north slopes. On the east slope of the Charleston Mountains they were not seen higher than 6,500 feet altitude while on the west slope they were seen at about 7,000 feet altitude, and on the west slope of the Sheep Mountains one was seen as high as 8,500 feet.

These little ground squirrels are quite active, but, even though they may be numerous in a locality, they are seldom seen when one is on foot unless he travels very cautiously. However, when one is driving a car through a country occupied by these squirrels he gets a much better estimate of their real abundance, as they are approached before they are able to scamper off behind a bush or dart down a hole.

These squirrels come out and begin their foraging before sunrise and do not retire until late evening after sundown. They are most active in early morning and late afternoon, thus partly avoiding the extreme heat of mid-day. They are usually found far from water, but when water is near they frequent it. At Corn Creek Station a large wooden tank about twelve feet high which was kept nearly half full of water to prevent its drying out, permitted enough water to escape to maintain a small pool at the base of the tank. The numerous tracks of these ground squirrels in the mud indicated that they visited the water quite frequently. One squirrel had evidently climbed up the ladder at the side of the tank and while seeking a drink had fallen into the tank and was drowned. Also at St. Thomas one of these squirrels was found drowned in a water tank. From February 3 to 7, 1931, these squirrels were seen abroad in Kyle Canyon (Mohave Yucca belt) and around Indian Springs. The testes of the males were greatly enlarged. At this time it was cold enough to be snowing in the mountains above 6,500 feet altitude, but where the squirrels were seen it had been raining.

Young ground squirrels about half-grown were seen during the latter part of May and in early June at 4,000 feet altitude. On June 21, 1929, at Wheeler Well, altitude 6,600 feet, two young Antelope Ground Squirrels were heard calling from some brush; they were about 20 feet apart and called alternately. As one of them was approached (it was observed to be about one-fourth grown) it ran out of the brush and hid its head under a small weed, apparently thinking that it was entirely concealed. As it was approached again it ran back into the brush from which it had come originally, uttering as it went its faint cry of fright. At Cedar Basin among the junipers and granite boulders these squirrels were often seen sitting "picket pin" fashion on top of the boulders under which were their refuge holes.

A male specimen, collected at Cedar Basin, August 9, 1929, had its cheek pouches distended with 187 seeds of cactus (*Opuntia*).

Eutamias panamintinus juniperus Burt
Juniper Chipmunk

Eutamias panamintinus juniperus Burt, Jour. Mammalogy, 12, August, 1931: 298.

The Juniper Chipmunk is confined, as far as our collecting data show, to the piñon pine-juniper belt, being replaced in the yellow pine belt and above by the larger *Eutamias palmeri* Merriam. Specimens of *juniperus* were taken at "The Lodge," altitude 6,500 feet, at Wheeler Well, altitude 6,700 feet, and near Willow Creek, altitude 6,700 feet. They were most common at Wheeler Well.

The molt from the worn and faded winter pelage to the bright summer pelage apparently takes place in June. Certain specimens taken at Wheeler Well, June 19, 1929, were completely molted while others taken on the previous day (June 18) had not commenced the molt. They are easily distinguished from the larger *palmeri* by their gray heads and rumps, more tawny coloration of body and much paler ventral surface of the tail.

On June 18, 1929, I came upon two half-grown chipmunks as they were playing among some large rocks. They immediately sought refuge beneath the rocks, but after a few minutes one of them ventured into the open again. When it saw the strange object it immediately "froze" in its tracks. Shortly the other one came out and did the same thing. It was estimated that the first one to appear remained motionless for at least four minutes; however, the time was not taken. The other one very shortly came out of his "freeze" and scurried off among the rocks. When the first chipmunk to appear came out of his "freeze" he was very cautious. He surveyed the situation carefully, presumably to make certain that the strange object was not going to harm him. At first he moved his tail slowly from side to side, then hopped a short distance and looked and listened again. Once he gave a little grunt. After deciding that all was well he began to hop about over the rocks apparently looking for any morsel of food that he might find. He came within six inches of my feet and when oatmeal was carefully sprinkled on the rock he ate some of it. An adult chipmunk peered over the rock, but did not remain long. Soon afterwards an adult, probably the same one, began to call a short distance away and the two youngsters that I had been watching immediately hurried off in that direction. It seemed evident that they responded to the call of the adult.

The food of this species is apparently made up in large part of the fruits of the piñon pines and junipers. Their workings were common around these trees.

Eutamias quadrivittatus nevadensis Burt

SOUTHERN NEVADA CHIPMUNK

Eutamias quadrivittatus nevadensis BURT, Jour. Mammalogy, 12, August, 1931: 299.

This species was encountered only in the Sheep Mountains, where it was found abundantly in and above the yellow pine belt. In the yellow pine belt this species and *Eutamias dorsalis grinnelli* Burt were found in about equal numbers; however, *grinnelli* does not extend its vertical range up into the higher belts as does *nevadensis*, but is found commonly throughout the piñon pine-juniper belt.

Individuals of *nevadensis* were found to be quite fearless when approached cautiously. They were most numerous along old fallen logs and rocky cliffs and slopes. Two young individuals were collected September 18 and 19, 1930. Four females, collected July 9, 10 (two on this date), and 13, 1929, and one collected September 19, 1930, had the mammary glands active. The breeding season is apparently somewhat delayed in this species, but our data are too incomplete to make any definite statements.

Most of the specimens taken from July 7 to 13 inclusive were in the new

summer pelage. Some of them, especially the females that were suckling young, still retained much of the worn winter pelage. The molt begins on the head and progresses back over the body in a more or less irregular fashion. One specimen, no. 15,925, shows a definite molt line just anterior to the hips. The anterior portion of the body is in the new summer pelage. The new pelage is much brighter, displaying more of the tawny color, than the old winter pelage.

Eutamias palmeri Merriam
Palmer Chipmunk

This species of chipmunk inhabits the higher parts of the Charleston Mountains and as far as known is confined to this mountain range. Howell (1929, p. 92), evidently basing his statement on specimens that were available and on Merriam's (1897, p. 209) statement in the original description, gives the zonal range of this species as Canadian. Subsequent collecting shows that the species ranges, vertically, from the yellow pine belt, 7,000 feet altitude, to timber line, nearly 12,000 feet altitude.

Individuals of this species become fairly tame around places of habitation. At the Charleston Park summer resort where they were quite abundant, they lived beneath the cabins and in piles of rock and wood. Higher up in the mountains they were found most commonly along the rock cliffs or old logs that afforded hiding places. Young individuals about one-half grown were collected at 8,000 feet altitude, June 6, 1928, and a half-grown individual was collected at 10,000 feet altitude July 9, 1928. The young are much grayer and less tawny in coloration than the adults.

The molt apparently begins on the head and progresses posteriorly. In certain specimens it progresses in a definite line whereas in others it is irregular over the body. Certain specimens collected in early June at 8,000 feet altitude were completely molted, whereas a male, no. 14,549, collected at 11,700 feet altitude July 4, 1928, still had the worn winter pelage except for a small area on his head. The time of molt, as in other species, is delayed somewhat in the higher altitudes.

Our data on the food habits of this species are rather meager, but their workings beneath the conifers led us to believe that a considerable proportion of their food consisted of the fruits of these trees. One specimen, collected July 1, 1928, had its cheek pouches distended with small seeds (*Gentianaceae*?).

Eutamias dorsalis utahensis Merriam
Utah Cliff Chipmunk

Chipmunks of this species were encountered at Cedar Basin, Virgin Mountains, at an altitude of 3,500 feet. They were found most commonly on the rocky slopes among the scattered junipers and piñon pines. Three specimens were collected in 1929, and three more in 1930; they were very shy and elusive. Merriam (1897, p. 211) in his account of this species says, "They were so shy that only one was secured, although Mr. Bailey and I spent several hours in watching the rock heaps into which they had disappeared." Our observations bear out the above account.

The food of these chipmunks consists, in part at least, of the seeds of the junipers and piñon pines. One specimen collected August 5, 1929, had its cheek pouches distended with the fruit of the juniper, and pine cones with the seeds partly removed were found on boulders occupied by chipmunks.

Eutamias dorsalis grinnelli Burt

PALLID CLIFF CHIPMUNK

Eutamias dorsalis grinnelli BURT, Jour. Mammalogy, 12, August, 1931:300.

This subspecies was found to be abundant in the Sheep Mountains where it occurred, in part, in the yellow pine belt with *nevadensis*. Its vertical range is throughout the piñon pine-juniper belt and well into the yellow pines. This form, as we observed it, differs markedly in habits from *utahensis* farther east. The latter, as described under that form, was very shy. In contrast to this, individuals of *grinnelli* were easily approached. Their habits, as far as discernible from our data, are in a general way similar to those of *palmeri* from the Charleston Mountains. Although they were found in the yellow pine belt in practically the same associations as *nevadensis*, they apparently occupied slightly different ecologic niches. Both species were trapped in the same places, but individuals of *grinnelli* were found more commonly on the slopes while those of *nevadensis* were found chiefly in the canyon bottoms.

When we visited the Hidden Forest again in September, 1930, we found the chipmunks much less abundant than they were formerly. One of the four specimens collected contained four large bots (*Cuterebra* sp., last instar) in its skin along the ventral surface and a fresh wound where one had recently emerged from beneath its neck. It seems almost impossible that the chipmunk could have lived under the conditions. Another specimen had an old scar where a larva had emerged from its back.

Cooper Hawks and Sharp-shinned Hawks were found very abundantly here on our last visit. Probably the hawks and the bots combined had something to do with the depletion of chipmunks in this area.

Most of the specimens taken between July 7 and 25, 1929, are in the summer pelage. A few specimens still have the old winter pelage on the rump, but the anterior two-thirds of the body is in the new pelage. The molting process is in most cases fairly regular, there being a definite line of molt. In one specimen, no. 15,942, the mid-dorsal region is molted back to the region of the hips, but the sides are molted only as far posteriorly as the shoulders. None of the specimens show the irregular molt that is found in certain individuals of *palmeri*. In the old pelage the white tips of the hairs are worn off, displaying more of the tawny coloration and less of the gray than is shown in the fresh summer pelage.

Thomomys bottae centralis Hall

VALLEY POCKET GOPHER

Thomomys perpallidus centralis HALL, Univ. Calif. Publ. Zool., 32, July 8, 1930:445.

Pocket gophers were found locally throughout the region in which collect-

ing was done. They were found to be most numerous on the desert floor in moist conditions. At Pahrump Ranch, Indian Springs, Las Vegas, and St. Thomas, gopher workings were common, especially in the few tilled fields or near water. This form ranges vertically from the low desert upward nearly to timber line in the Charleston Mountains where two specimens were taken in bristle-cone pine association. Others were taken at various altitudes along the slope of the mountain.

Although there is much variation in the large series of gophers taken, all except those from the Sheep Mountains appear to be referable to *centralis* with which most of the specimens from southern Nevada agree in every essential, as shown by comparisons with a topotypical series of *centralis* at the Museum of Vertebrate Zoology, University of California. However, certain of the specimens collected at Las Vegas, Indian Springs, and Pahrump Ranch grade toward *Thomomys bottae amargosae* Grinnell in coloration while others are nearer typical *centralis*. Specimens from St. Thomas approach *Thomomys bottae planirostris* Burt in coloration of both upperparts and underparts except for one specimen, no. 16,265, the underparts of which are whitish as in typical *Thomomys bottae aureus* J. A. Allen. The skulls are all essentially alike and agree with those of typical *centralis*; they are distinct from those of *amargosae* or *planirostris*.

The high mountain specimens differ slightly from those of the valleys. They are on the average somewhat smaller and more richly colored; the zygomatic arches tend to be wider posteriorly than anteriorly instead of nearly parallel-sided as in the lowland specimens. However, these slight differences in the series at hand do not seem sufficient to warrant the naming of a new race at this time. One would expect to find a differentiated form in the higher zones of the Charleston Mountains and they might with further study prove to be distinct.

On the valley floor the workings were found in the sandy soil where excavation must have been comparatively easy. Higher up in the mountains the soil is extremely rocky and difficult to work. At these levels the gophers were found to be comparatively inactive during the dry summer months, although they had evidently been quite active during the winter months while the snow covered the ground, as evidenced by the old workings and plugs that had been made in the snow. In their diggings the gophers often brought out rocks as large or larger than an ordinary hen's egg.

At Cold Creek a colony of gophers was found near an irrigation ditch where the vegetation was chiefly prickly poppy (*Argemone platyceras hispida*) on which the gophers were apparently feeding. Leaves of the poppy were observed to have been pulled down into the holes before they were plugged. At this place during July, 1928, the gophers were quite active, especially in the mornings and evenings while it was cool.

The number of young per litter is normally four, judging from the number of embryos found in pregnant females. Five of the six females taken at Trout Canyon from June 13 to 15, 1929, were either pregnant or suckling young. One female, no. 15,681, contained four 31 mm. embryos and another, no. 15,682, four 13 mm. embryos. The breeding season evidently extends over most of the summer.

Thomomys phelleoecus Burt
SHEEP MOUNTAINS POCKET GOPHER

Thomomys phelleoecus BURT, Jour. Mammalogy, 14, February, 1933:56-57.

This diminutive gopher occupied the canyon bottoms and rocky canyon sides high up in the Sheep Mountains. The small mounds were seen at but two localities in the Hidden Forest at 8,500 feet altitude and above. The limited vegetation that would serve for food and the extremely rocky soil were probably influential factors in keeping the numbers limited. The affinities of *phelleoecus* are with the eastern California mountain forms, *Thomomys scapterus* Elliot, *Thomomys providentialis* Grinnell, and *Thomomys oreoecus* Burt, rather than with the low desert form *centralis* which occurs about the bases of the Sheep Mountains.

Perognathus longimembris panamintinus Merriam
PANAMINT POCKET MOUSE

This species was found chiefly on the low desert where the soil was predominantly sandy. However, it was not confined to this type of soil as six specimens taken at Mormon Well, Sheep Mountains, were in the piñon pine-juniper belt and were caught on rocky slopes. The Sheep Mountains specimens average considerably darker than those taken lower down on the desert, but compare very closely in other respects. Specimens taken at Pahrump Ranch are palest of the series collected, but all are apparently referable to *panamintinus*.

Three of the specimens, nos. 14,256, 15,539, and 15,564, had the cheek pouches full of seed, the following plants being represented: burro-weed (*Franseria dumosa*), plantain (*Plantago* sp.), and grass (*Festuca* sp.). Many of them filled or partially filled their pouches with oatmeal before they were caught in the traps. A female, no. 15,651, collected June 8, 1929, had been suckling young as there was milk in her mammary glands.

At Indian Springs we found one other species of *Perognathus* (*Perognathus formosus formosus* Merriam) to be common in the same locality where we caught *panamintinus*. However, *formosus* was caught chiefly on the rocky barren slopes while *panamintinus* was found on the sandy desert floor, although *formosus* invaded a narrow strip of *panamintinus* territory at the foot of the slope. At this locality each of these species was apparently restricted to its peculiar set of soil conditions.

Inasmuch as practically nothing is known of the individual ranges of many of the smaller mammals, it seems advisable to publish any data on this subject however incomplete. On the night of July 1, 1929, at Las Vegas, an individual was caught by the tail and succeeded in liberating itself, but left the tail behind. On the following night presumably the same mouse was caught in a trap set about 350 yards (estimated by stepping it off) from the set that had caught the tail on the previous night. There appears to be little doubt that it was the same mouse; the tail had been amputated only a short time before as the wounded portion was not yet healed over; furthermore, it was amputated at the proper place to match the rest of the tail. If the tail and the mouse were one and the same individual it would indicate a range, within twenty-four hours, for the in-

dividual with a diameter of at least 350 yards. This species was also taken in Kyle Canyon, altitude 4,500 feet.

Perognathus parvus magruderensis Osgood
Mt. Magruder Pocket Mouse

This species was found in the lower part of the piñon pine-juniper belt; most of the specimens being caught near the lower edge of this association. They were caught on the rocky slopes and sage brush flats; the type of soil apparently had little to do with determining their local distribution.

The food during the summer months consists chiefly of small seeds as was indicated by the cheek pouch contents of many of the specimens taken. Seeds or twigs of the following species of plants were represented in the cheek pouch contents: *Gilia* sp., loco-weed (*Astragalus* sp.), goosefoot (*Chenopodium* sp.), mistletoe (*Phoradendron* sp.), and mustard (*Cruciferae*). One individual, no. 14,176, had a small round pebble in one cheek pouch; apparently it was mistaken for a seed.

P. p. magruderensis was not found associated with any other species of pocket mouse. In the Sheep Mountains, where *panamintinus* was found in the piñon pine-juniper belt, *magruderensis* was not taken. It was found only in the Charleston Mountains.

The young are evidently born in late May or early June. Three females taken on May 23 and 24, and June 7 respectively, 1928, each contained four embryos. Females that were nursing young were taken on May 24 and 25, 1928, and one June 13, 1929. A young individual about two-thirds grown was taken July 25, 1928. The mammae are arranged in three pairs, one pair pectoral and two pairs inguinal.

The Charleston Mountains specimens, as compared with a topotypical series of *magruderensis*, agree very closely in size and general coloration of the upperparts. However, they show a slight variation from the topotypical series in a less distinct lateral line, and in almost pure white underparts and under side of tail, which are tinged with a cream color in the topotypes. The differences are apparently so slight as to fall well within the range of variation that should be expected in a given race of pocket mice. Topotypes of *Perognathus parvus olivaceus* Merriam have not been available for comparison. However, the Charleston Mountains specimens average slightly larger than topotypes of *magruderensis* and the latter is described by Osgood (1900, p. 38) as "Similar to *P. p. olivaceus*, but very much larger . . ." Under the circumstances it seems best to consider the Charleston Mountains specimens as *magruderensis*.

Perognathus formosus formosus Merriam
Long-tailed Pocket Mouse

The Long-tailed Pocket Mouse was taken chiefly on the low desert, although a few were taken in juniper association. It was found to be most abundant at Indian Springs, where it occupied the rocky slopes that were nearly barren of vegetation. A short distance below on the desert floor individuals of this species were occasionally caught, but the species was soon replaced by *Dipodomys merriami merriami* Mearns and *Perognathus longimembris panamintinus*.

The food of *formosus*, as with the other species of *Perognathus* here considered, was found to be chiefly seeds as indicated by the cheek pouch contents which contained seeds of the following: grass (*Festuca* sp.), creosote bush (*Larrea*), plantain (*Plantago* sp.), and mesquite (*Prosopis* sp.). The young are born, as far as our data show, in May, June, and possibly July. A female containing four 15 mm. embryos was taken June 4, 1929, at Indian Springs. Young individuals about one-half grown were taken in Kyle Canyon, at 4,500 feet altitude, on May 30 and 31, 1928. At Cedar Basin in the juniper belt young individuals one-half grown were taken August 7, 1929.

The molt, as shown by three specimens collected July 30 (two on this date) and August 2, 1929, begins at the head and progresses caudad and ventrad. The molt lags along the lateral line so that nearly the entire back is molted before it progresses to the ventral surface posterior to the fore legs. The molt is apparently regular and progresses in a definite line.

Perognathus penicillatus penicillatus Woodhouse
COLORADO DESERT POCKET MOUSE

Two specimens, one adult and one young about two-thirds grown, of this species were taken on July 30 and August 2, 1929. These two were both caught along the banks of Muddy Creek near St. Thomas. At this place they were found with *formosus*, but apparently occupying a slightly different ecologic niche. The latter was found more commonly on the desert away from the creek, whereas the two specimens of *penicillatus* were taken near the water in rather dense growths of vegetation.

Dipodomys merriami merriami Mearns
MERRIAM KANGAROO RAT

This is by far the most common species that we encountered on the sandy desert. We found them at all the localities visited on the desert floor. They were most numerous at Indian Springs, where on the night of June 6, 1929, of seventy specimens caught in a string of 112 rat and mouse traps thirty-nine were of this species. According to the trapping records they were more numerous at this locality than all the other species of small mammals combined. We also encountered them, but in fewer numbers, in the piñon pine-juniper belt in Kyle Canyon and Cedar Basin.

The food of *merriami* consists of green leaves and seeds as well as the dry seeds of plants. Many of the specimens had dry seeds in their cheek pouches, others green seeds and seed pods or green leaves. Seeds of the following plants were represented in cheek pouch contents: grass (*Festuca octoflora*), peppergrass (*Lepidium* sp.), goosefoot (*Chenopodium* sp.), mustard (*Cruciferae*), loco-weed (*Astragalus* sp.), *Pentstemon* (?), and mesquite (*Prosopis* sp.).

The number of young per litter, judging from the number of embryos in pregnant females, is from one to four. Nine pregnant females contained embryos as follows: three contained one embryo each, five two embryos each, and one contained four embryos. From this it appears that the average number is two. The mammae are in three pairs, one pair of pectoral and two pairs of inguinal. Pregnant females were taken as early as May 27 and as late as August 1.

The fall molt, which is complete, begins on the head and progresses caudad and ventrad along the sides. Two specimens taken July 17 and 19, 1929, have the new pelage on the anterior portion of the head; the line of molt has nearly reached the eyes on one and the ears on the other. Two specimens collected August 7, 1929, are molted well back of the ears. The molt follows a definite line, progressing more rapidly on the back than on the sides. Apparently a partial spring molt occurs in some instances, but this may be abnormal due to age or unnatural conditions. However, Grinnell (1922, p. 77) in discussing the molt of this species says: "It must be recalled here that in *Dipodomys* but one molt occurs each year, in the fall." In two specimens at hand, nos. 15,523 and 15,543, collected May 27 and 28, 1929, a definite molt was taking place at the time they were collected. The line of molt is just posterior to the shoulder region in the one and anterior to the hip region in the other. The new pelage anterior to the line of molt is definitely shorter and of a slightly different color than the pelage posterior to the line. Whether or not the molt at this time is complete over the entire body cannot be determined from the specimens at hand.

Dipodomys microps levipes (Merriam)

Light-footed Kangaroo Rat

This species was common on the low desert; one specimen was taken at the lower edge of the piñon pine-juniper belt. We found *levipes* most commonly on the desert floor in the same associations that *merriami* and *Dipodomys deserti deserti* Stephens were found; *levipes* was much less abundant than *merriami,* but was apparently about as common as the large *deserti.* The latter was, according to our experience, confined to sandy areas whereas *levipes* was to be found also on the rocky slopes and gravelly desert floor.

Both dry seeds and green vegetation were found in the cheek pouches, so the nature of the food of this species is evidently similar to that of *merriami.* The following plants were represented in cheek pouch contents: plantain (*Plantago* sp.), pepper grass (*Lepidium* sp.), sage brush (*Artemisia* sp. leaves), and quail brush (*Atriplex* sp. leaves).

A female collected May 30, 1929, contained two very small embryos; this was the only pregnant female taken. Another female collected June 4, 1928, had been suckling young. The mammae of individuals in this species are arranged in two pairs, both inguinal.

In *levipes,* as in *merriami,* some individuals may molt in the spring. Four specimens collected at Indian Springs and one at Pahrump Ranch on June 6 (three on this date), 7, and 10, are from one-third to one-half molted. One specimen collected at Corn Creek Station July 17, 1929, has the new summer pelage except for a strip about one-half inch wide on the rump. In addition to these specimens there is in the Dickey collection one specimen, no. K 358, collected May 21, 1922, that shows a stage in the process of molting. The line of molt is well behind the ears, showing the new unworn pelage on the head and the old worn pelage on the back and rump. There are also three specimens, nos. K 951, K 1022, and K 1033, collected August 8, 16, and 18, 1922, that show stages apparently in the fall molt. The line of molt in each of these specimens is near the middle of the back. Of thirteen July taken specimens, other than the one just alluded to, two collected

July 7, 1922, show the beginning of a molt on the head; the others do not show signs of molting. To sum up the above briefly: specimens showing some stage of molt were collected on the following dates: May 21, June 6, 7, and 10, July 7 and 17, and August 8, 16, and 18. This means one of two things: (1) if there is but one molt a year it may occur from May to August; (2) if there are two molts a year the spring molt occurs in May and June with an occasional molt delayed until early July and the fall molt takes place in August. The evidence from specimens at hand is not sufficient to make a definite statement one way or the other, but in any case the molt seems not to be confined to the autumn months.

Dipodomys deserti deserti Stephens
BIG DESERT KANGAROO RAT

This large kangaroo rat was found most commonly among the low sand dunes where the soil was sandy and easy to excavate. The large burrows of these rats which led into their underground retreats were common in sandy areas and in the early morning the many tracks that were in evidence indicated a considerable amount of activity during the previous night.

The food of this species apparently consists of seeds and green vegetation. A specimen taken June 10, 1929, had its cheek pouches full of green vegetation. Cheek pouch contents revealed the following: seeds of creosote bush (*Larrea*), leaves of sage bush (*Artemisia* sp.), and fragments of stem and fruiting capsule of *Scrophulariaceae* (probably *Pentstemon*).

Young individuals about two-thirds grown were taken on June 7 and July 31, 1929. A female with the mammae active was taken June 6, 1929, and another as early as February 6, 1931. The condition of the uterus of the latter indicated that she had given birth to young only a short time before she was collected. The mammae are arranged in three pairs, two inguinal and one pectoral. The species was taken at Pahrump, Indian Springs, Corn Creek, and St. Thomas.

Onychomys torridus longicaudus Merriam
LONG-TAILED GRASSHOPPER MOUSE

This species was found locally throughout the area in which we worked on the low desert. Specimens were usually taken at or near places where the vegetation was rather profuse for a desert region—in small ravines or near water. They were not wholly confined to these conditions as individuals were caught on the open desert.

Three females taken on May 28 and 30, 1928, and August 7, 1929, each contained three embryos. A female taken June 4, 1928, had the mammary glands active.

According to our trapping records the grasshopper mice are less numerous than most other species of small mammals in this area. However, the trapping record probably does not give a fair estimate of the number of individuals present (Bailey and Sperry, 1929, p. 3). They may be much more numerous than it would seem from trapping records alone. This species was taken at 4,500 feet altitude, (Kyle canyon), Las Vegas, Indian Springs, St. Thomas and Cedar Basin.

Reithrodontomys megalotis megalotis (Baird)
Desert Harvest Mouse

This species was taken on the low desert only and here was confined to local areas, usually near water, where the vegetation was rather dense for a desert region. Locality records are as follows: Pahrump, Indian Springs, Las Vegas, Wheeler Well, Willow and Cold Creeks, Mormon Well, and St. Thomas.

A female collected at Pahrump Ranch July 12, 1929, contained four small embryos in the left horn of her uterus, none in the right horn. Another female collected July 22, 1928, at Willow Creek had the mammary glands active. Young half-grown individuals were taken at various dates through June and July of 1928 and 1929.

Peromyscus crinitus stephensi Mearns
Stephens Canyon Mouse

This species was found to be a common inhabitant of the dry rocky slopes at about 5,000 feet altitude. It was also found, but in lesser numbers, lower down on the desert at the edge of the low hills and higher up in the yellow pine belt. Miller (1924, p. 319) gives the zonal range of this subspecies as Lower Sonoran. We found them from as low as 3,200 feet altitude at Indian Springs (lower edge of Mohave Yucca) to as high as 10,000 feet altitude, Kyle Canyon, in the yellow pine, fir, and aspen associations. They seem to prefer rocky situations. They were found most abundantly at Willow Creek where the catch outnumbered *Peromyscus maniculatus sonoriensis* (Le Conte) in the trap lines. Specimens were also taken at Mormon Well and Hidden Forest.

Peromyscus eremicus eremicus (Baird)
Desert White-footed Mouse

The Desert White-footed Mouse was found in common with *stephensi* in the lower part of the piñon pine-juniper belt (6,000 feet altitude). The two species apparently occupied similar ecologic niches at this point as they were caught together in the same trap lines. *P. e. eremicus* apparently does not penetrate the higher altitudes, as it was not taken above the piñon pine-juniper belt.

A female collected at Pahrump Ranch June 12, 1929, contained four embryos, two in each horn of the uterus. Another female collected May 28, 1928, had the mammae active. Specimens were collected at the following localities: Kyle Canyon, altitude 4,500 feet; Willow Creek, altitude 6,000 feet; Pahrump Ranch, altitude 2,667 feet; Muddy Creek, altitude 1,250 feet; Indian Springs, altitude 3,280 feet.

Peromyscus maniculatus sonoriensis (Le Conte)
Sonora White-footed Mouse

The most abundant and most commonly met with species was the Sonora White-footed Mouse. Individuals of this species were taken in almost every type of association available from the low desert to above timber line. On the extreme peak of the Charleston Mountains, which is above timber line, this was the only species of mammal taken. It was found to be most numerous at an altitude of

about 6,500 feet where the Mohave Yucca ceases and the junipers and piñon pines begin; on the low flat desert they were nearly or wholly replaced by the species of *Dipodomys* or *Perognathus*.

Pregnant females were taken from May 24 to July 12. The number of embryos per female ranged from three to six with four and five as the usual numbers.

Peromyscus boylii rowleyi (Allen)

ROWLEY WHITE-FOOTED MOUSE

This species was found in the piñon pine-juniper and yellow pine belts. One specimen, no. 14,773, was taken at 6,000 feet altitude, Wheeler Well, at the lower edge of the piñon pine-juniper belt. Most of the specimens taken were in rocky situations along the deep canyons. At 8,000 feet altitude in Kyle Canyon they were found associated with *Peromyscus truei truei* (Shufeldt) as well as with the smaller *sonoriensis*. *P. b. rowleyi* was not found to be abundant at any one locality; however, the species was fairly common on the north side of the canyon at the Charleston Park summer resort. Strangely enough none were taken on the south side of the canyon at this place. The north side of the canyon was covered with dense chaparral whereas on the south side there were pines and aspens. The mice at this locality were apparently limited in their range to the warmer south-facing rocky slopes that were densely covered with chaparral. This was also the case with *truei*, but *sonoriensis* was taken on both sides of the canyon.

A female taken June 10, 1928, altitude 8,000 feet, contained four embryos. Another female taken June 13, 1928, was suckling young.

Peromyscus truei truei (Shufeldt)

TRUE WHITE-FOOTED MOUSE

The True White-footed Mouse was taken from the piñon pine-juniper belt, Mormon Well, to the bristle-cone pine belt, Charleston Peak, inclusive. It is an inhabitant of the rim-rock areas where vertical rock cliffs line the canyons. This species was found to be more abundant than *rowleyi*, but was outnumbered by *sonoriensis*. It was taken in both the Charleston and Sheep ranges.

Young individuals, about two-thirds grown, were taken at various dates in June and July. Two females, each with the mammae active, were taken on July 25, 1928, and July 25, 1929, respectively.

Neotoma lepida lepida Thomas

DESERT WOOD RAT

Desert Wood Rats were found to be common throughout the low desert region and were taken at every locality below 6,500 feet altitude. They were found also in the piñon pine-juniper belt, but less commonly. At Hidden Forest, Sheep Mountains, we took two specimens of this species at an altitude of 8,500 feet. This was chiefly yellow pine association, but being on the west slope, tongues of piñon pines and junipers penetrated the higher belts along the exposed ridges. However, the specimens were taken in the bottom of the canyon in yellow pine and fir associations. At this locality they were caught in the same places that we caught the bushy-tailed wood rat, *Neotoma cinerea acraia* (Elliot); the two speci-

mens taken were caught in traps that netted bushy-tailed wood rats on previous nights. In Kyle Canyon, Charleston Mountains, the two species were taken together at an altitude of 6,500 feet. At this place the bushy-tailed wood rats were caught only on the cool north sides of the cliffs, whereas the desert form was taken on the warmer south-facing slopes as well. It would seem that the bushy-tailed wood rat is less adaptable and is more strictly limited in its altitudinal range than is the Desert Wood Rat.

Neotoma lepida lepida is apparently a very prolific species. The number of young per litter is normally four and two or more litters may be brought forth each year. Three pregnant females, collected May 22, and June 3 and 7, 1928, contained four embryos each. The female collected June 3, 1928, was taken from her nest which was beneath a large wooden platform near a cabin. The platform was lifted and when the nest was exposed she waddled away slowly with four young about one-fourth grown clinging to her teats. She was easily caught because of her heavy burden. Upon dissection she was found to contain four 5 mm. embryos. The small nest was made up of fine grasses and there were only a few sticks and cacti beneath the platform. The close quarters made it unnecessary for her to pack in large quantities of material.

During the latter part of May and early June, 1928, many young individuals were caught in the mouse-trap lines out through the open brush; adults were usually taken along cliffs or near heavy brush. The young were evidently spreading from their original homes and searching out new territory in which to establish themselves.

Neotoma cinerea acraia (Elliot)

Mount Whitney Bushy-tailed Wood Rat

Bushy-tailed wood rats were common in the Charleston Mountains from the lower edge of the piñon pines and junipers to timber line. They were also found in the Sheep Mountains at 8,500 altitude. Their nests were common along the cool, shady rock cliffs that were protected from the sun for all or most of the day. Scattered sticks and wood rat droppings were to be found along nearly every cliff.

The breeding season evidently lasts over most of the summer months. Young half-grown wood rats were taken as early as May 20, and pregnant females taken as late as July 5. A female taken June 23, 1928, contained five 50 mm. embryos; one taken July 5, contained three 40 mm. embryos. The females have only four teats, all inguinal.

On the night of June 21, 1928, a female with the mammary glands active was shot while being chased along a vertical cliff by another wood rat, presumably a male. The two were watched for a moment with a spot light before the one was shot. They scurried over the high cliff with perfect ease, the female always about three feet ahead of the other rat; apparently they were going through their courting antics.

The stomachs of two females taken May 20, 1928, were distended with finely chewed green vegetation that had the characteristic odor of *Artemisia.*

In his revision of the genus *Neotoma,* Goldman (1910, p. 95-96) gives for the geographic range of *Neotoma cinerea cinerea* (Ord): "Rocky Mountain

region in southern British Columbia, Montana, Idaho, western Wyoming, Utah, northern Arizona, and thence westward through the mountains of central Nevada to the southern part of the Sierra Nevada in California." He thereby places Elliot's form *acraia* in synonymy under *cinerea*. Later Goldman (1917, p. 111-112) described what he supposed to be a new race from the Charleston Mountains of southern Nevada under the name *Neotoma cinerea lucida*. The type locality of *cinerea* is given as (Goldman, 1910, p. 195) Great Falls, Cascade County, Montana. That of *acraia* was originally given as Hot Springs, Long Canyon, Mount Whitney, Inyo County, California. However, according to Grinnell (1913, p. 315) it is really Jordan Hot Springs, near Kern River, Sierra Nevada, Tulare County, California.

Comparisons of a series of 47 topotypical specimens of *lucida*, skins and skulls of both adults and young from the Charleston Mountains, made with a series of specimens from the Mount Whitney region and the White and Panamint Mountains in California leads me to the conclusion that the southern Nevada form is the same as that occupying the California side, which is here considered as *acraia*. In addition to the Dickey collection I have had access to comparative material in the collections at the Museum of Vertebrate Zoology of the University of California at Berkeley.

In his original description of *lucida* Goldman (1917, p. 111) says concerning this form: "Size smallest and color among the palest of the known forms of *Neotoma cinerea*. Most closely allied to *Neotoma cinerea cinerea*, but decidedly smaller and paler; skull differing in detail but sphenopalatine vacuities absent as in *N. c. cinerea*." Further, in speaking of the skull he says: "Decidedly smaller than those of the other forms of *N. cinerea*, with zygomata relatively broader anteriorly and narrower posteriorly, the sides therefore more nearly parallel; frontal region flatter, less depressed along median line . . . " In the original description of *N. c. acraia* Elliot (1903, p. 247) says: "Similar to *T.* [*N.*] *cinerea*, but much paler, tail paler, foot smaller."

By none of the above characters as given by Goldman (*loc. cit.*) am I able to separate the Charleston Mountains specimens from the Mount Whitney specimens, nor the Charleston Mountains specimens from those collected in the White and Panamint Mountains. As for size, the Charleston Mountains specimens average slightly larger than those at hand from the Mount Whitney region (see measurements). When a series of skins of comparable pelages are arranged side by side the extremes in degree of paleness or darkness of coloration from either region can be matched with skins from the other region. In the cranium I am unable to see any differences between specimens from the two localities. This also holds for specimens from the White and Panamint Mountains, California, and the Sheep Mountains, Nevada. There is a slight difference in average size of specimens from different localities, but to my mind the differences are so small as not to warrant separation.

From the comparisons noted above it seems that, with the present additional material, we are not justified in recognizing *lucida* as a valid race, therefore it is placed in synonymy under *acraia*. Unfortunately topotypes of *cinerea* were not available, but measurements of topotypes given by Goldman (1910, p. 97) and

measurements of available specimens from northern Nevada and Idaho, show that in the southernmost part of the range of *cinerea* as given by Goldman (*loc. cit.* p. 95-96) individuals average much smaller than those in the northern part of the range (compare measurements). As one passes northward there is a gradual increase in size so that the two extremes are easily distinguishable on size alone. Also there is a change from the pale southern form to the darker northern one. There is probably a fairly wide belt of intergradation in northern Utah, but specimens from that region have not been available for study and I cannot be certain of this point. With the gradual gradation of one into the other it seems best to have a name for each of the extremes, so it is here suggested that Elliot's name *acraia* be revived and applied to at least the California and southern Nevada specimens and the name *cinerea* applied to those from Idaho northward. This principle of naming the extremes where there is a gradual change from one to the other has been illustrated by Osgood (1901, p. 50-51). The subspecies *acraia* and *cinerea* grade into each other more gradually than do any of the other subspecies of *cinerea* examined by me.

(List continued on Page 422)

TABLE II. AVERAGE, MINIMUM, AND MAXIMUM MEASUREMENTS OF *Neotoma cinerea* FROM FIVE LOCALITIES IN NEVADA, CALIFORNIA, AND IDAHO.

Locality	*No. Specimens*	*Length*	*Tail Vertebrae*	*Hind Foot*	*Basilar Length of Hensel*	*Length of Nasals*	*Zygomatic Breadth*	*Interorbital Constriction*	*Length of Incisive Foramina*	*Alveolar Length of Upper Molar Series*
MALES										
Charleston Mts., Nevada	12	361 (337-385)	150 (140-160)	42 (40-44)	42.1 (40.0-44.3)	19.4 (18.6-20.4)	25.6 (23.8-26.7)	5.9 (5.5-6.1)	11.5 (10.3-12.2)	9.8 (9.6-10.5)
White Mts., California	7	365 (335-396)	158 (148-171)	41.4 (39-44)	40.0 (37.0-43.9)	18.2 (16.9-20.3)	25.0 (23.0-27.8)	5.6 (5.4-5.8)	11.3 (9.9-12.6)	9.9 (9.7-10.2)
Mt. Whitney region, Calif.	11	355 (315-379)	155 (129-167)	42 (40-44)	40.5 (38.8-42.5)	19.2 (17.6-21.0)	25.2 (24.2-26.1)	5.7 (5.4-6.2)	10.8 (10.2-11.9)	9.8 (9.3-10.2)
White Pine County, Nevada	12	380 (350-427)	159 (144-185)	42 (40-44)	42.8 (39.7-47.8)	19.8 (17.6-22.8)	26.4 (24.2-28.9)	5.8 (5.4-6.2)	11.4 (10.8-12.6)	9.6 (9.1-9.9)
Fremont County, Idaho	3	403 (357-453)	171 (145-193)	47 (44-52?)	46.2 (41.6-51.1)	21.4 (18.9-23.8)	28.4 (26.5-31.1)	5.7 (5.3-6.2)	12.3 (11.7-13.4)	10.7 (10.4-11.0)
FEMALES										
Charleston Mts., Nevada	7	344 (325-375)	146 (136-155)	39 (37-40)	39.5 (38.5-42.6)	18.4 (17.7-18.9)	24.5 (23.3-25.2)	5.6 (5.4-6.0)	10.7 (10.0-11.5)	9.7 (9.2-11.1)
White Mts., California	14	355 (280-384)	153 (138-164)	40.8 (37-44)	40.0 (36.5-42.0)	18.6 (16.5-20.0)	25.1 (22.8-26.6)	5.8 (5.2-6.1)	11.0 (9.7-11.8)	9.7 (9.1-10.2)
Mt. Whitney region, Calif.	13	361 (340-389)	157 (140-181)	40 (38-42)	40.8 (38.7-44.0)	18.9 (17.6-20.1)	25.3 (23.8-26.1)	5.7 (5.4-6.0)	10.8 (10.1-11.8)	9.8 (9.4-10.1)
White Pine County, Nevada	13	372 (341-393)	152 (140-163)	40.7 (38-43)	40.5 (38.9-41.8)	18.9 (17.7-20.3)	25.2 (24.3-26.3)	5.7 (5.2-6.3)	11.3 (10.7-11.5)	9.5 (8.9-9.9)

Ondatra zibethica bernardi Goldman
MUSKRAT

Ondatra zibethica bernardi GOLDMAN, Proc. Biol. Soc., Washington, 45, June 21, 1932:93.

Muskrat signs were seen along Muddy Creek near St. Thomas where a male specimen was caught September 23, 1930, at a hole in the bank at the edge of the small stream.

The farmers near St. Thomas told us that in former years the muskrats were abundant along Muddy Creek, but during the winter of 1927 a trapper took most of them. Their signs were more plentiful in 1930 than they were during our visit in 1929.

Mus musculus musculus Linnaeus
HOUSE MOUSE

Four house mice were caught at Pahrump Ranch, June 12, 1929. Two of them were caught in a ranch house and two along an irrigation ditch about 100 yards from the nearest building. None of the mice were saved, but we read from the field notes that the two taken outside were of a noticeably paler coloration than those taken in the house. According to Harper (1930, p. 49-52) there are possibly two races of house mice that have been introduced into this country, i. e., *Mus musculus musculus* Linnaeus and *Mus musculus azoricus* Schinz. The latter form is paler and more buffy beneath. Harper suggests that there is a possibility that we have a pale outdoor form and a dark indoor form, but that "the meager evidence thus accumulated in regard to the possible occurrence of a light-colored 'outdoor' race of house mice in America is inconclusive or contradictory." It is improbable that the original stock brought to this isolated spot in the desert came from more than one source.

Erethizon epixanthum couesi Mearns
ARIZONA PORCUPINE

Porcupines were found in both the Charleston and Sheep Mountains, but not commonly. At the Charleston Park summer resort a female containing one large embryo was killed June 29, 1929, by Mr. E. W. Griffith, owner of the resort. As related by Mr. Griffith, the porcupine entered his cabin at 2 A. M. The noise awakened him and when he arose to investigate he found the porcupine in his kitchen. When he attempted to drive it out of the cabin he was met with opposition, so he gave the porcupine what he thought was a light blow over the nose with a broom handle. The blow was evidently harder than he had anticipated as it killed the animal. A week later we visited the spot where the porcupine had been buried and obtained the specimen for a skeleton. The large embryo was covered with a heavy coat of black hair. Mr. Griffith said that he killed a porcupine at the same place several years before and that those two were the only ones that had been reported from the mountains.

The only other signs of porcupines that we saw in the Charleston Mountains were in Lee Canyon at 8,200 feet altitude. At this place a few of the small firs had been barked from top to bottom. It looked like work of the previous winter as

many of the trees were dead or nearly so. Porcupine droppings and small dead branches were strewn around the bases of the trees. The small branches and the extreme tops of the small trees must have been barked in the winter when the snow was deep because it would seem impossible for a porcupine to work on the small branches without a firmer support than the branches themselves.

In the Sheep Mountains we again found signs of porcupines and here as in the Charleston Mountains it was the fir that was being used predominantly as food. An occasional mark would be seen on a small yellow pine where a porcupine had sampled the cambium and occasionally small pines were barked, but usually the damage was done to the firs. At this place a skull with a portion of dried skin clinging to it was found on one of the high ridges and on July 13, 1929, an adult female was caught in a steel trap set in the bottom of a deep canyon with meat bait.

Lepus californicus deserticola Mearns
DESERT JACK RABBIT

Jack rabbits were abundant about the farming districts. There were hundreds of them at Pahrump Ranch, Indian Springs, Corn Creek Station, Las Vegas, and St. Thomas. Higher up in the forested parts of the mountains an occasional jack rabbit was seen. One was seen as high as 11,000 feet altitude on a ridge sparsely timbered with bristle-cone pines.

Down on the desert the jack rabbits remained in the low brush during the heat of the day. To protect themselves from the extreme heat they made horizontal or nearly horizontal burrows in the sand that had accumulated at the bases of clumps of brush. In the evenings they came in to the green spots around the ranches to feed. In some localities they were numerous enough to do considerable damage to the crops.

Sylvilagus nuttallii grangeri (Allen)
BLACK HILLS COTTONTAIL

This species was found in the Charleston Mountains at altitudes of 6,900 feet and above, in the piñon pine-juniper and yellow pine belts. They were found in the heavy chaparral along the canyon bottoms and slopes. Two females were taken, one at Wheeler Well at 6,900 feet and one in Kyle Canyon, 8,000 feet altitude. One taken June 22, 1928, had the mammary glands active. They were quite rare in this area.

Sylvilagus audubonii arizonae (Allen)
ARIZONA COTTONTAIL

The Arizona Cottontail was found commonly on the desert, especially around the ranches and in sand dune areas where the dense chaparral covering the sand dunes served as excellent shelter. Cottontails were often jumped from the low brush and invariably they sought the sand dunes for safety where many of them entered burrows.

At Pahrump Ranch, Indian Springs, and St. Thomas, cottontails were even more numerous than jack rabbits. One specimen was taken at Hidden Forest in the yellow pine-fir belt, altitude 8,500 feet.

Odocoileus hemionus hemionus (Rafinesque)
ROCKY MOUNTAIN MULE DEER

Deer were common in the higher parts of the Charleston Mountains, as judged from numerous signs, though few deer were actually seen. Pine needles were found to make up part of their diet during June, 1929.

Deer were not found in the Sheep Mountains. Their absence from this range can possibly be accounted for by the scarcity of water. The other conditions are practically the same as they are in the Charleston Range.

Ovis canadensis nelsoni Merriam
DESERT BIGHORN

Bighorn sheep are still common in the Sheep Mountains. On the evening of July 7, 1929, as we arrived at Hidden Forest and were picking out a place to camp, we heard rocks rattling on the steep mountain side to the south of the canyon. Seven bighorns, led by a large ram, were making their way slowly up the precipitous slope. Single file the big ram led them zig-zagging in and out along the cliffs and stopping at short intervals to look back and rest a bit. They continued slowly up the slope and out of sight. Their signs were numerous on the ridges where they apparently spent most of their time during the summer months. On September 20, 1930, as we were coming out of the Hidden Forest area we saw an adult ram and ewe with two lambs in the bottom of the canyon. We stopped the car and watched them as they went up a nearly vertical cliff, the ram following the others this time. Mr. Richardson at Corn Creek, who had cattle in the mountains, told us that a bunch of twenty-four sheep were watering at his cattle tank. This was the only watering place of any consequence in the mountains.

A skeleton of a large ram (nearly complete) was found in the bottom of a canyon in the Hidden Forest. Two of the limbs had been carried away by carnivores.

Sheep were formerly common in the Charleston Mountains according to reports by ranchers of that region, but there are only a few left, if any. Mr. Raycraft at Pahrump told us that there had been a small bunch of them along the southwest border of the mountains. We failed to see any signs of them, but obtained the skull of a young male that had been picked up near a water hole at the edge of the mountains northeast of Pahrump.

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TRANSACTIONS

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WEST AMERICAN SPECIES OF THE GENUS LIOTIA

BY

A. M. STRONG

Los Angeles, California

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WEST AMERICAN SPECIES OF THE GENUS LIOTIA

BY

A. M. STRONG

Los Angeles, California

In identifying the Mollusca from the Gulf of California and adjacent islands collected by the expeditions sponsored by the California Academy of Sciences, it was found the species in the genus *Liotia* had received but little attention in the literature of west coast shells. Thirteen species and three varieties have been described from the west coast of North and South America, one by Gray, five by Carpenter, one by Baker and the remainder by Dall.[1]

The descriptions are scattered through several publications, few of which are easily accessible. Only four of the species have been figured and seven are reported only by the types. Numerous specimens of some of the species are now available in the various California collections and two species and one variety that appear to be undescribed were found in the collection of the California Academy of Sciences. For these reasons it seemed advisable to review the available data on the west coast species, figuring the types or authentic specimens where such could be secured, and add the descriptions of the new forms. The writer wishes to acknowledge his indebtedness to Dr. Fred Baker of San Diego for the loan of specimens and other aid, to Dr. Alexander Wetmore of the U. S. National Museum for the photographs of the types on deposit there, and to Dr. G. Dallas Hanna of the California Academy of Sciences for photographs and assistance in the preparation of the plates and manuscript.

The genus *Liotia* Gray, 1847[2], (type by original designation *Delphinula cancellata* Gray, 1828, recent, Peru and Chile) contains small, turbinate or depressed, umbilicated shells with a nacreous inner layer

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[1] Since the preparation of the manuscript for this paper two species have been added to the list, both fully described and figured. They are as follows: *Arene winslowae* Pilsbry and Lowe, Proc. Acad. Nat. Sci., Phila., vol. 84, 1932, p. 86, pl. 9, figs. 1, 2, 2a; and *Arene hindsiana* Pilsbry and Lowe, loc. cit., pp. 86-87, pl. 9, figs. 4, 5. The first is from San Juan del Sur, Nicaragua, and the second from Manzanillo, Mexico. They thus validate *Arene* as of generic rank and, in a later paper, loc. cit., vol. 85, 1933. p. 380, Pilsbry confirms this, defining *Arene* fully, but adds "The limits of *Arene* seem very nebulous."

[2] *Liotia* Gray, Proc. Zool. Soc. Lond., 1847, p. 145.

and a thickened, continuous lip which is attached to the body whorl for only a short distance. In the original description of the genus it was said that the operculum is corneous and multispiral, with a calcareous layer formed of spirally arranged pearly particles. However, the opercula are known only in a few of the species placed in the genus and in some of these it is said that the calcareous layer hardly shows. Carpenter expressed doubt in placing the three species he described from Mazatlan in the genus as the opercula were unknown, but the shell characters would seem to be sufficient. In the systematic arrangement the family *Liotiidae* is placed between *Turbinidae* and *Trochidae*. In many ways the shells resemble those of the genus *Leptothyra* in the first family but differ by the absence of any sign of a denticle on the columella, in the thicker and more continuous outer lip, and in many species by the wide umbilicus. From the genus *Margarites* in the second family they differ in the heavier shell and thickened lip. Nothing seems to be known of the ecology of the species in the genus, which is widely distributed and contains a number of fossil forms.

A single subgenus, *Arene* H. & A. Adams, is recognized, which, though named in 1854, was not defined by a type until 1928, when Woodring[3] designated *Turbo cruentatus* Megerle von Mühlfeld, recent, West Indies. Woodring stated that the subgenus differs from the typical form in having "a higher turreted spire and a scaly sculpture." Dall had previously described three species from the west coast which he placed in this subgenus, evidently with a different idea of its characters. The first of these, *L. cookeana,* proves to be the young of a well known California shell quite similar to the type of the genus. The other two, *L. californica* and *L. pacis,* seem to be subgenerically distinct from the rest of the west coast species. They are much larger shells with the axial sculpture projecting beyond the margin of the whorls, giving them a stellate form. As this paper reviews the species from a limited fauna only no attempt to determine the proper subgeneric grouping is made.

The following key gives the principal differences in the species reviewed or described in the paper and this in turn is followed by detailed descriptions and references. It is believed that all species described from the west coast are included.

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[3] Miocene Mollusks from Bowden, Jamaica: Carnegie Inst. of Washington, Publ. 385, pt. 2, 1928, p. 422.

KEY TO THE WEST COAST SPECIES OF LIOTIA

A[1]. Axial ribs and spiral cords of about equal strength.
- B[1]. Shell turbinate, spire elevated.
  - C[1]. Shell thick, solid; diam., 5 mm., Peru and Chile ..... *cancellata*
  - C[2]. Shell thin, translucent; diam., 0.6 mm. (young). Mazatlan ..... *c-b-adamsii*
- B[2]. Shell flattened, spire depressed; diam., 5 mm. Monterey to Gulf of California ..... *fenestrata*

A[2]. Spiral cords strong, axial ribs faint or absent.
- B[1]. Body whorl with a peripheral and a second minor cord; diam., 2 mm. Galapagos Islands ..... *scitula*
- B[2]. Body whorl with 2 or 3 major cords and many spiral threads; diam., 4.7 mm. Magdalena Bay to Tres Marias Islands ..... *rammata*
- B[3]. Body whorl with 3 cords and faint axial striae; diam., 0.9 mm. Mazatlan ..... *striulata*
- B[4]. Body whorl with about 6 equal spiral cords.
  - C[1]. Axial ribs absent; diam., 3 mm. Monterey to Tres Marias Islands ..... *acuticostata*
    - D[1]. Spiral cords finer, shell smaller; diam., 2.3 mm. Gulf of California ..... var. *stearnsi*
  - C[2]. Axial riblets showing between the spiral cords; diam., 3 mm. San Pedro to San Martin Island ..... var. *bristolae*
  - C[3]. Axial ribs heavy, producing nodes at crossing of spiral cords; diam., 3.7 mm. San Diego ..... var. *supranodosa*
- B[5]. Body whorl with about 8 unequal spiral cords; diam., 6 mm. Socorro Island ..... *socorroensis*
- B[6]. Body whorl with about 11 spiral cords.
  - C[1]. Umbilicus bounded by 2 strong, nodulous cords; diam., 5.5 mm. Gulf of California ..... *carinata*
  - C[2]. Umbilicus bounded by 3 close-set, beaded cords; diam., 6.2 mm. Panama ..... *olivacea*
  - C[3]. All cords beaded. Panama ..... var. *litharia*
- B[7]. Body whorl with about 20 spiral cords; diam., 1.7 mm. Cape San Lucas ..... *lucasensis*

A[3]. Axial ribs strong, spiral sculpture fine or absent.
- B[1]. Axial ribs 6, ending in blunt tubercles at periphery; diam., 23 mm. Lower California ..... *californica*
- B[2]. Axial ribs 8, ending in spines at the periphery; diam., 15 mm. La Paz ..... *pacis*

1. **Liotia cancellata** (Gray)

Plate 30, figures 10, 11.

Delphinula cancellata GRAY, Spicil. Zool., pt. 1, 1828, p. 3, pl. 6, fig. 8. Arica (Chili).

Delphinula cobijensis REEVE, Conch. Icon., vol. 1, *Delphinula,* October, 1843, pl. 5, figs. 22, a, b.

Liotia cancellata GRAY, Tryon, Man. Conch., vol. 10, 1887, p. 109, pl. 36, fig. 2.—Dall, Proc. U. S. Nat. Mus., vol. 37, 1910, p. 239.

Not *Delphinula cancellata* Kiener or Reeve.

This species is described by Reeve as *D. cobijensis* as follows: "Shell turbinated, very small, ribs convex, regularly latticed with equidistant, transverse and longitudinal ribs; umbilicus middling; lip simple." Tryon gives the diameter as 5 mm. and says of it: "Has the sculpture and umbilicus of *L. fenestrata* Cpr. but is more elevated."

The shell described and figured by Kiener as *Delphinula cancellata* comes from the Philippines and is quite distinct. Gray's species is cited as the type of the genus and Dall gives the range as Peru and Chile. As no specimens are available, Reeve's figure of *Delphinula cobijensis* is reproduced.

2. **Liotia c-b-adamsii** Carpenter

??*Liotia c-b-adamsii* CARPENTER, Mazatlan Catalogue, 1857, p. 249, no. 315.

A free translation of Carpenter's description is as follows:

"Shell very thin, diaphanous, white, turreted; whorls three, swollen, subangular above, elegantly cancellated with radiating lirae (on the last whorl 22) nodulous at the intersection with about 8 spiral lirae; first whorl and a half smooth; radiating lirae vanishing on the base; umbilicus small; aperture subcircular, lip continuous, scarcely interrupted by the penultimate whorl. Long. 0.6, lat. 0.55 mm. Div. 70°." To this is added the note in English, "Although this is clearly a young shell, its characters are well marked. It has the texture of *Vitrinella,* but is distinguished by the turreted form, and by the large size and short length of the apical portion. The rest of the shell is beautifully decussated by radiating lirae, obsolete on the base, knotted by revolving lirae, three of which appear on the base."

It was described from a single specimen collected at Mazatlan. No further reference to the unfigured species was found in the literature and no specimens answering to the description have been seen by the writer in collections.

3. **Liotia fenestrata** Carpenter

Plate 28, figures 10, 11, 12; plate 30, figures 7, 8, 9.

Liotia fenestrata CARPENTER, Suppl. Rep. Brit. Assoc., 1864, pp. 612, 652. Proc. Calif. Acad. Nat. Sci., vol. 3, 1865, p. 158.—Tryon, Man. Conch., vol. 10, 1887, p. 109.—Oldroyd, Stanford Univ. Publ., Univ. Ser. Geol. Sci., vol. 2, pt. 3, 1927, p. 170.

Liotia cookeana DALL, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 8.—Oldroyd, Stanford Univ. Publ., Univ. Ser. Geol. Sci., vol. 2, pt. 3, 1927, p. 171, pl. 91, figs. 12, 13, 13a.—Strong and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 19, p. 5.

A free translation of Carpenter's description is as follows:

"Shell small, at first subdiscoidal, later variable, brownish white; nuclear whorls smooth, flat, apex depressed; normal whorls two and a half, convex, clathrate by about 15 equidistant radiating and 7 spiral ribs, with deep pitted interspaces; aperture circular, frequently slightly sloping, slightly attached to the parietal wall; umbilicus large, showing the whorls within; inner lip sinuated in the umbilical region."

Carpenter's type was collected by Cooper at Catalina Island, "beach to 40 fms., dead." A series of young specimens from San Martin Island, Lower California, in the collection of the California Academy of Sciences shows that the top of the first, often the second, and sometimes the third whorl is flat and sculptured only with microscopic spiral striae. Beginning on the second whorl, axial ribs develop and extend from the sharply angulated shoulder, over the rounded base to a spiral cord bounding the umbilical region. A little later spiral ribs begin to show in the interspaces and gradually increase in strength. The type of *Liotia cookeana* Dall, figured by Mrs. Oldroyd, is a specimen of three whorls at this stage of the development of the sculpture. As the shell increases in size, the spiral ribs become stronger until they equal the axial ribs and both gradually extend over the more rounding upper surface of the whorl until they reach the suture, forming the characteristic pitted surface of the adult. In the adult shell the flattened surface of the early whorls has the appearance of an eroded apex.

Dall gives the range of the species as from Monterey to San Martin Island and of *Liotia cookeana* as from South Coronado Island to the Gulf of California. Specimens are not uncommon along the coast of southern California in beach drift or inhabited by hermit crabs. It would seem to be an off-shore species in comparatively shallow water. The flattened form and deeply pitted surface easily distinguish it from the other

local species of the genus. The specimen figured was collected at Isthmus Cove, Catalina Island, and measures, height, 2; diameter, 4 mm.

4. **Liotia scitula** Dall

Plate 28, figures 7, 8, 9.

Liotia scitula DALL, Proc. U. S. Nat. Mus., vol. 56, 1919, p. 358.

Dall's description of this species is as follows:

"Shell minute, white, with flecks of brown, of about four whorls, including a very minute smooth nucleus; spire flattened, suture distinct; axial sculpture of fine incremental lines, somewhat wrinkled in front of the suture, and on the last whorl developing a narrow row of beads at the suture and crenulating on the base the margin of the umbilicus; spiral sculpture of a very prominent, minutely crenulated keel at the periphery and a smaller one on which the suture is laid; the margin of the narrow umbilicus is also thread-like; aperture rounded except where modified by the external sculpture; the body with a glaze of enamel, the pillar lip somewhat thickened; height of shell 1, maximum diameter 2 mm."

The type specimen was dredged among the Galapagos Islands in 40 fms. No further reference to the species was found.

5. **Liotia rammata** Dall

Plate 29, figures 4, 5, 6; plate 30, figures 1, 2, 3.

Liotia rammata DALL, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 7. Proc. Calif. Acad. Sci., ser. 4, vol. 19, 1930, p. 19.

Dall's description of this species is as follows:

"Shell depressed-turbinate, of four whorls, the first two and two-thirds whorls and the base of the last whorl white, the upper surface of the last whorl and one-third reddish purple; the suture distinct, not appressed; spiral sculpture on the spire of two prominent threads, the posterior angulating the shoulder, the anterior growing more feeble on the last whorl; the rest of the surface is uniformly covered with fine, equal, close-set, smaller threads, slightly roughened by fine incremental lines; the only axial sculpture consists of feeble more or less obsolete plications in front of the suture; base rounded, with a small perforate umbilicus of which the margin is not crenate; aperture circular, thickened below. Breadth of shell, 4.7; height, 4.0 mm."

Dall's specimens came from Magdalena Bay on the outer coast of Lower California. Specimens in the California Academy of Sciences collection from the Tres Marias Islands off the west coast of Mexico seem to fit the description in every way. The only difference observed is that some of them have three instead of two major spiral cords and in the color pattern which is quite variable. Most of them are marked with alternating white and reddish or brownish radiating stripes. The specimen figured came from the Tres Marias Islands and measures, height, 4 mm.; maximum diameter, 4.5 mm.

6. **Liotia striulata** Carpenter

?*Liotia striulata* CARPENTER, Mazatlan Catalogue, 1857, p. 248, no. 314.

A free translation of Carpenter's description is as follows:

"Shell turban-shaped, spire subelevated, white, solid; whorls three, rounded, radiately feebly and closely striate, with three slightly prominent spiral carinae; umbilicus large, the edge somewhat radiately wrinkled; aperture slanting, solid, the interior rounded, scarcely touching the penultimate whorl. Long. .675, lat. .925 by .75 mm., div. 130°." To this is added the note in English: "The thickness of this little shell is extraordinary, being at the posterior portion of the aperture nearly .005 inches. The whorls are rounded, obscurely carinated, and most minutely and closely striated in the direction of growth."

No further reference to this unfigured species, of which a single specimen was collected at Mazatlan, was found in the literature and no specimens have been seen in the collections which would answer to the description.

7. **Liotia acuticostata** Carpenter

Plate 29, figures 7, 8, 9.

Liotia acuticostata CARPENTER, Suppl. Rept. Brit. Assoc., 1864, pp. 612, 652. Proc. Calif. Acad. Nat. Sci., vol. 3, 1865, p. 159.—Oldroyd, Stanford Univ. Publ., Univ. Ser. Geol. Sci., vol. 2, pt. 3, 1927, p. 170.—Strong and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 19, 1930, pp. 5, 19.

A free translation of Carpenter's description is as follows:

"Shell small, subglobose, white; nuclear whorls two, smooth, apex elevated; normal whorls three, with two raised carinae on the spire and six on the last whorl; sutures subrectangular; aperture circular; lip little contracted, conspicuous; umbilicus not large."

Carpenter listed it from Monterey and Catalina Island. Dead shells are not uncommon in the dredgings from shallow water near the kelp fields along the southern California coast. The California Academy of Sciences collection contains specimens from Guadalupe Island, Magdalena Bay, Cape San Lucas, and the Tres Marias Islands. These are of the typical form which is a glossy, almost translucent, white shell with sharp spiral ridges and no axial sculpture other than lines of growth. The specimen figured measures, height, 2.5; maximum diameter, 3 mm. It was collected at Isthmus Cove, Catalina Island.

8. **Liotia acuticostata stearnsi** Dall

Liotia acuticostata stearnsi DALL, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 8.

Dall's description of this variety is as follows:

"Resembling *acuticostata* but smaller, with more numerous and less prominent spiral cords. Height, 2.3; width, 2.3 mm."

Dall gives the range as the Gulf of California. No specimens answering to this description were found in the collections.

9. **Liotia acuticostata bristolae** Baker

Plate 29, figures 13, 14, 15.

Liotia acuticostata radiata DALL, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 8.—Oldroyd, Stanford Univ. Publ.., Univ. Ser. Geol. Sci., vol. 2, pt. 3, 1927, p. 170.

Liotia acuticostata bristolae BAKER, The Nautilus, vol. 43, 1929, p. 72.[4]

Dall's description of this variety is as follows:

"Shell resembling the type but with numerous radiating riblets in the interspaces between the revolving costae."

This seems to be the normal form of the species, the absence of the fine radiating riblets in the interspaces being the result, at least in many cases, of a worn surface. Specimens of the variety are more common than the typical form along the southern California coast, and the California Academy of Sciences has specimens from La Paz, Amortajada Bay of San José Island, and Coyote Bay in Concepción Bay, all in the Gulf of California. The specimen figured was dredged off South Coronado Island, near San Diego, California, by Dr. Fred Baker, and measures, height, 2; diameter, 3 mm.

10. **?Liotia acuticostata supranodosa** Strong, new subspecies

Plate 30, figures 4, 5, 6.

?Liotia acuticostata CARPENTER, Tryon, Man. Conch., vol. 10, 1889, p. 109, pl. 36, fig. 1.

This form differs from the typical in having heavy axial ribs which cross the stronger spiral cords, thus producing a series of nodes at the intersections, similar to those in *L. fenestrata*. The spiral cords are less acute than in *L. acuticostata*, the umbilicus is nearly or quite closed and there is a faint indication of a tubercle on the columella. The size, shape and general appearance of the two forms are very similar. Height, 3.6; diameter, 3.7 mm.

Holotype.—No. 5472, Mus. Calif. Acad. Sci.; collected at San Diego, California, by Henry Hemphill.

The type specimen is one of a lot of four found in the Hemphill collection at the California Academy of Sciences and marked: "Types.

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[4] Dall's name, *Liotia acuticostata radiata*, was preoccupied by *Delphinula radiata* Kiener (a *Liotia*) in Icon. Coq. Viv., vol. 10, 1838-1839, p. 7, pl. 4, fig. 9.

Liotia acuticostata variety *supranodosa*. Identified by P. P. Carpenter." I cannot find that Carpenter ever described the form in print. In a recent letter Dr. Pilsbry states that the specimen figured in Tryon's Manual of Conchology as *Liotia acuticostata* Carpenter seems to be a *Leptothyra*. A comparison of Hemphill's specimens with this figure shows that they might well be the same form. Examination of other specimens dredged off the coast of southern California having the same characters as Hemphill's specimens shows that many of them have a distinct tinge of red, something not seen in any of the specimens of *L. acuticostata* or variety *bristolae*. In order to avoid confusion it seems best to validate the name with a description and illustrations. An examination of the operculum may show that in spite of the close similarity this should be considered a distinct species and placed in *Leptothyra*. Material for such a determination is not now available.

11. **Liotia socorroensis** Strong, new species

Plate 31, figures 4, 5, 6.

Shell of about four shouldered whorls and a minute flattened nucleus of a little over one whorl; spiral sculpture of three strong, more or less nodulous spiral cords on the periphery, of which the upper forms the angle to the shoulder of the whorls; between this and the suture are two smaller, distinctly nodulous cords with a third developing on the last quarter turn; base flattened, with three nodulous spiral cords, of which the first is the smallest and the last forms a sharp carina around the deep, funnel shaped umbilicus; axial sculpture consisting of numerous, sharp, close-set, waved riblets which are faint on the nodules of the spiral cords; aperture circular, with a thick, continuous lip, the outer edge of which is crenulated by the spiral sculpture. The type (which is one of 12 specimens from Socorro Island, off the west coast of Mexico), measures, height, 5; maximum diameter, 6 mm. It is of a reddish cast with a few small, irregularly placed, lighter spots. The other specimens show much variation in color and color pattern. The operculum is multispiral with a central nucleus and a concave calcareous outer surface, showing the pearly grains very distinctly. The species was collected in the inter-tidal zone.

Holotype.—No. 5478, Mus. Calif. Acad. Sci.; from Socorro Island, Mexico; collected by G. D. Hanna and E. K. Jordan, June, 1925.

In many ways this species resembles *Liotia carinata* Carpenter, from the Gulf of California, but differs in the flatter shell, fewer spiral cords

and much larger umbilicus. In this latter feature it resembles *Liotia fenestrata* Carpenter from California.

12. **Liotia carinata** Carpenter

Plate 28, figures 1, 2, 3; plate 31, figures 1, 2, 3.

?*Liotia carinata* Carpenter, Mazatlan Catalogue, 1857, p. 248, no. 313.

Liotia lurida Dall, Proc. U. S. Nat. Mus., vol. 45, 1913, p. 590; vol. 66, pl. 36, fig. 3.

Dall's description of this species is as follows:

"Shell small, dull red or purplish brown, more or less reticulated on the ridges, of about four and a half whorls; nucleus minute, flattish; last whorl with four strong, beaded, spiral cords with subequal interspaces, peripherally; between these and the suture, three slightly smaller similar cords, the space at the suture giving a channeled effect; on the base two less prominent cords and two wider nodulous ridges around the deep, rather narrow umbilicus; aperture circular, the outer lip thick, fringed by the ends of the spiral cords; axial sculpture of numerous fine radial threads, most obvious in the channels between the cords. Height of shell, 4.5; max. diam., 5.5 mm."

Carpenter described from a single young specimen, long. 0.75, lat. 1.1 by 1.0 mm., which was ash colored, reddish tinted. The description of the sculpture is almost identical with that of Dall.

Examination of a large number of specimens of all sizes collected by Captain Porter in the Gulf of California (probably from drift to Espíritu Santo Island) and now in the collection of Dr. Fred Baker, leaves little room for doubt that the two species are identical. The California Academy of Sciences also has specimens from La Paz, Isla Raza, and Concepción Bay, in the Gulf of California. Most of these specimens have the upper portion of the spire whitish, while the remainder of the shell is reddish or brownish, more or less mottled. In some of the specimens the cords are nearly equal with only two or three on the periphery, but in all cases the presence of the two strong, nodulous cords bounding the umbilicus is a distinguishing character. The specimen figured comes from Isla Raza, in the Gulf of California, and measures, height, 3.5; maximum diameter, 5 mm.

13. **Liotia olivacea** Dall

Plate 29, figures 1, 2, 3.

Liotia olivacea Dall, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 7.—Zetek, Los Mol. de la Republica de Panama, Revista Nueva, nos. 1, 2, 1918, p. 34.

Dall's description of this species is as follows:

"Shell of five depressed-turbinate whorls; suture narrow but not appressed, the color very dark olivaceous, the prominent sculpture paler; nucleus minute, decorticated, but apparently smooth; spiral sculpture of, on the upper part of the last whorl, four strong elevated cords with wider, almost channeled interspaces, the two posterior cords more adjacent; on the spire, only three cords are visible, the anterior more or less undulated; on the base are a single cord, a wide interval, then three more adjacent smaller plain cords, the three close-set beaded cords at the verge of the small perforate umbilicus; aperture circular, upper lip produced on the body, the interior pearly white; breadth of shell, 6.2; height, 5.5 mm."

The species has been reported only from Panama.

14. **Liotia olivacea litharia** Dall

Liotia olivacea litharia DALL, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 8.—Zetek, Los Mol. de la Republica de Panama, Revista Nueva, nos. 1, 2, 1918, p. 34.

Dall's description of this variety is as follows:

"Another specimen, long in the collection from Panama, but with no collector's name, has all the spiral sculpture strongly beaded, and may be called variety *litharia*. I have no doubt it is an extreme variety of the same species."

15. **Liotia lucasensis** Strong, new species

Plate 29, figures 10, 11, 12.

Shell minute, globose, shining white, of about three and a half slightly shouldered whorls and a very minute flattened nucleus of a little over one whorl; sutures not excavated; spiral sculpture of fine, raised, smooth, spiral threads, of which four appear on the first whorl, eight on the second and about twenty on the body whorl; axial sculpture absent; aperture circular, with a thick, continuous lip; umbilicus small. The type, which is one of about 200 more or less beach worn specimens, comes from Cape San Lucas and measures: height, 1.7; maximum diameter, 1.6 mm.

Holotype.—No. 5477, Mus. Calif. Acad. Sci.; from Cape San Lucas, Lower California, Mexico; collected by G. D. Hanna and E. K. Jordan, June, 1925.

This minute species would seem to be entirely distinct from any of the other west coast species placed in the genus.

16. **Liotia californica** Dall

Plate 28, figures 4, 5, 6.

Liotia californica, DALL, Bull. Mus. Comp. Zoöl., vol. 43, 1908, pp. 344-345.

Dall's description of this species is as follows:

"Shell large for the genus, rude, yellowish-white, depressed, with about six whorls, carrying at the shoulder six blunt, large, projecting tubercles; nucleus small, the nepionic whorls reticulate, flattened; the later whorls keeled bluntly at the shoulder, behind which they are flattened; on the flat area are two strong, elevated, spiral threads (which later disappear) close together, with the channels on either side reticulated by subequal and subequally spaced radial threads; on the last whorl all the sculpture on the upper part of the whorl, except the keel connecting the tubercles at the shoulder, has disappeared; the surface of the shell is of a spongy nature and all the sculpture is obscure as if deliquescent; the base is rounded with a large spiral, deep umbilicus, having one entering spiral keel which ends at a projection of the pillar lip; the verge of the umbilicus is rounded and spongy, outside of this ridge in the young it is constricted by a row of pits between which and the periphery are some obscure spirals in some specimens; aperture circular within, and when fresh brillliantly pearly, but the pearly coating is very thin and seems to disappear in dead shells; the outer margin of the aperture, which is very thick, is modified by the umbilical keel and other sculpture; operculum multispiral, with the external edges of the whorls fringed, very concave, and showing hardly any calcareous deposit. Alt. of adult, 15.0; of aperture, 9.0; max. diam., 23.0 mm."

The specimens were dredged from a sand bottom in 113 fms. at Albatross station 2984, off Lower California. No further reference to the species was found. It was placed in the subgenus *Arene* by Dall.

17. **Liotia pacis** Dall

Plate 28, figures 13, 14, 15.

Liotia pacis DALL, Bull. Mus. Comp. Zoöl., vol. 43, 1908, p. 345.

Dall's description of this species is as follows:

"This species is so similar to the preceding that it is best described by a comparative diagnosis. Than *L. californica* it is smaller, flatter, and more distinctly sculptured; the specimens examined have three and a half whorls besides the (lost) nucleus; it has eight peripheral projections instead of six, and they are flat, triangular, and spinose instead of bluntly tubercular; each projection is at the distal end of a distinct radial rib; the base is flatter, the umbilical ridge lower, and broken up into obliquely radial tubercles without any row of pits outside of it; the aperture is subcircular and the discrepancy between the inner and outer margins much less than in *californica*. Alt. of shell, 10.0; of aperture, 6.0; max. diam. of base, 15.0 mm."

The specimens were dredged from a mud bottom in 112 fms. off La Paz in the Gulf of California. No further mention of the species was found nor any specimens answering to the description. Dall placed it in the subgenus *Arene*.

EXPLANATION OF PLATES

PLATE 28

Figs. 1, 2, 3. *Liotia carinata* Carpenter. Holotype (of *L. lurida* Dall), No. 264,972, U. S. N. M.; Gulf of California. Diameter, 5.5 mm.; altitude, 4.5 mm. [Page 440]

Figs. 4, 5, 6. *Liotia californica* Dall. Holotype,, No. 110,662, U. S. N. M.; off Lower California, Albatross Sta. 2984, 113 fathoms. Diameter, 23 mm.; altitude, 15 mm. [Page 441]

Figs. 7, 8, 9. *Liotia scitula* Dall. Holotype, No. 194,975, U. S. N. M.; Galapagos Islands. Diameter, 2 mm.; altitude, 1 mm. [Page 436]

Figs. 10, 11, 12. *Liotia fenestrata* Carpenter. Holotype, (of *L. cookeana* Dall), No. 223,290, U. S. N. M.; South Coronado Island, Mexico. Diameter, 3 mm.; altitude, 1 mm. [Page 435]

Figs. 13, 14, 15. *Liotia pacis* Dall. Holotype, No. 110,663, U. S. N. M.; off La Paz, Gulf of California, 112 fathoms. Diameter, 15 mm.; altitude, 10 mm. [Page 442]

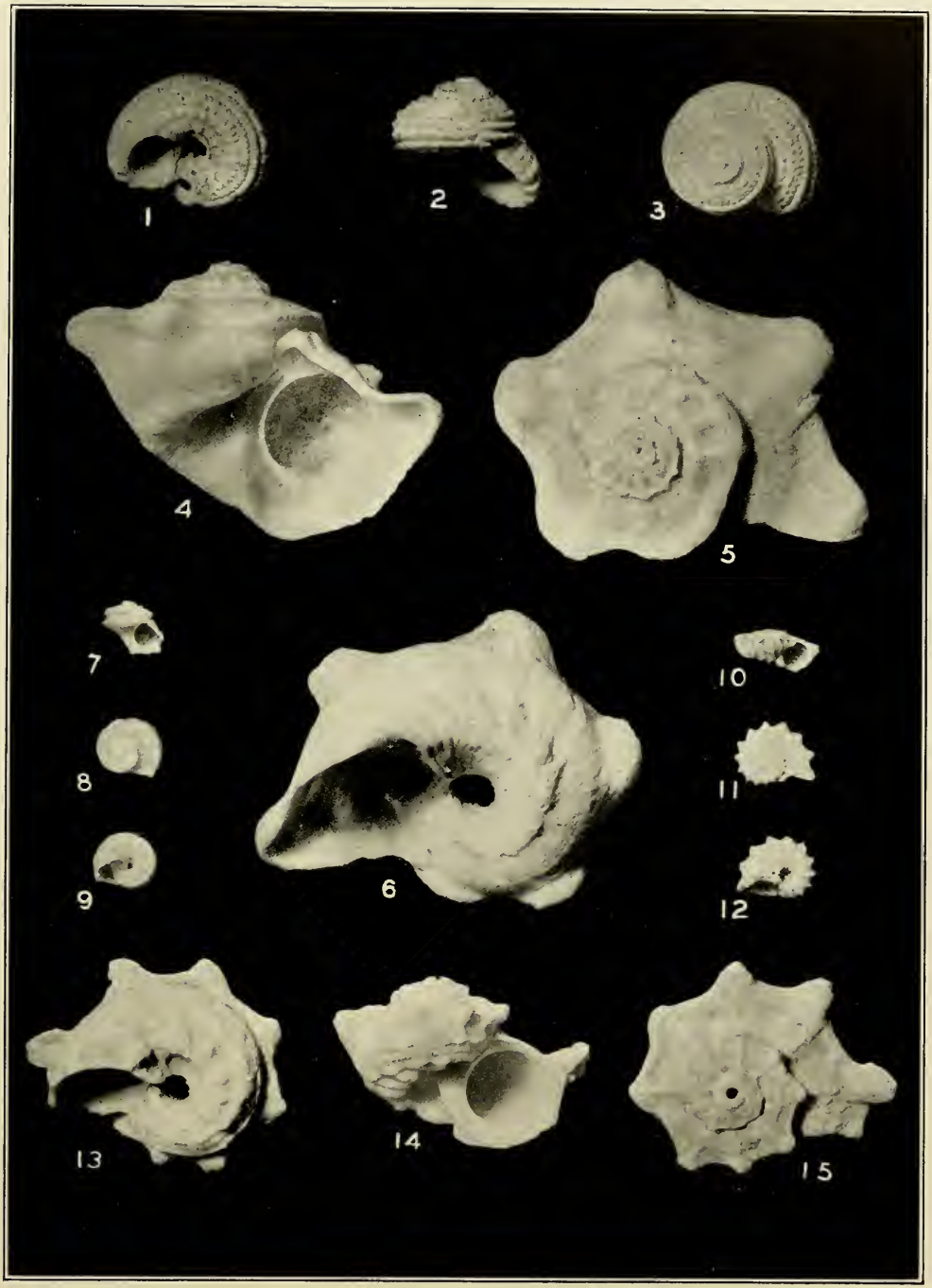
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PLATE 29

Figs. 1, 2, 3. *Liotia olivacea* Dall. Holotype, No. 331,837, U. S. N. M.; Panama. Diameter, 6.2 mm.; altitude, 5.5 mm. [Page 440]

Figs. 4, 5, 6. *Liotia rammata* Dall. Holotype, No. 217,908, U. S. N. M.; Magdalena Bay, Lower California. Diameter, 4.7 mm.; altitude, 4 mm. [Page 436]

Figs. 7, 8, 9. *Liotia acuticostata* Carpenter. Plesiotype, No. 5473, C. A. S.; Isthmus Cove, Catalina Island, California. Diameter, 3 mm.; altitude, 2.5 mm. [Page 437]

Figs. 10, 11, 12. *Liotia lucasensis* Strong, n. sp. Holotype, No. 5477, C. A. S.; Cape San Lucas, Lower California. Diameter, 1.6 mm.; altitude, 1.7 mm. [Page 441]

Figs. 13, 14, 15. *Liotia acuticostata bristolae* Baker. Plesiotype, No. 5474, C. A. S.; South Coronado Island, near San Diego, California. Diameter, 3 mm.; altitude, 2 mm. [Page 438]

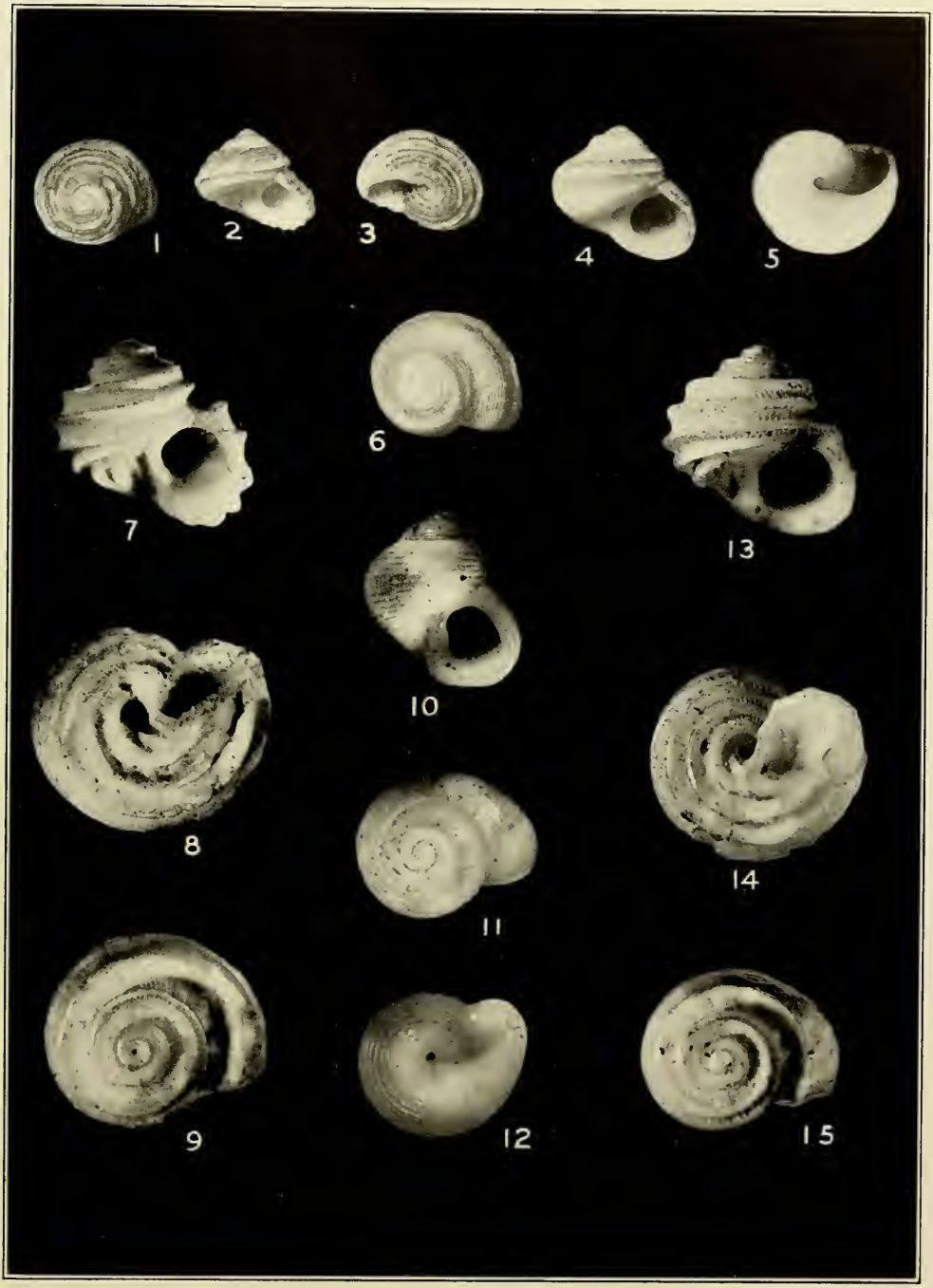
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PLATE 30

Figs. 1, 2, 3. *Liotia rammata* Dall. Plesiotype, No. 5479, C. A. S.; Maria Madre Island, Mexico. Diameter, 4.5 mm.; altitude, 4 mm. [Page 436]

Figs. 4, 5, 6. ?*Liotia acuticostata supranodosa* Strong, n. subsp. Holotype, No. 5472, C. A. S.; San Diego, California. Diameter, 3.7 mm.; altitude 3.6 mm. [Page 438]

Figs. 7, 8, 9. *Liotia fenestrata* Carpenter. Plesiotype, No. 5475, C. A. S.; Isthmus Cove, Catalina Island, California. Diameter, 4 mm.; altitude, 2 mm. [Page 435]

Figs. 10, 11. *Liotia cancellata* (Gray). Photographic copies of Reeve's figures of *Delphinula cobijensis*, Conch. Icon., vol. 1, *Delphinula*, 1843, pl. 5, figs. 22a, 22b. Original diameter of figure 10 [22a], 8 mm.; altitude, 6.7 mm.; no measurements of the shell were given by Reeve. [Page 434]

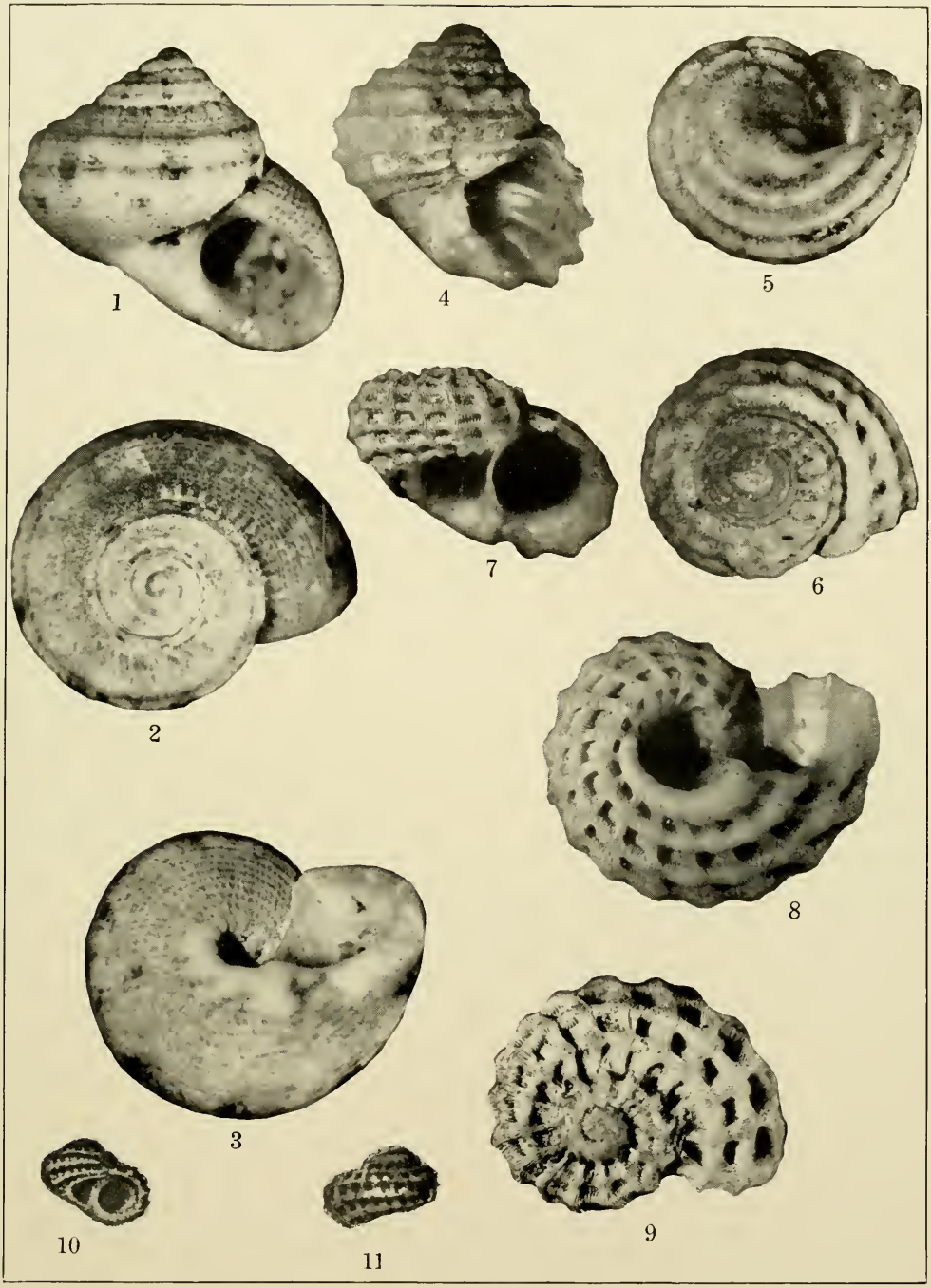
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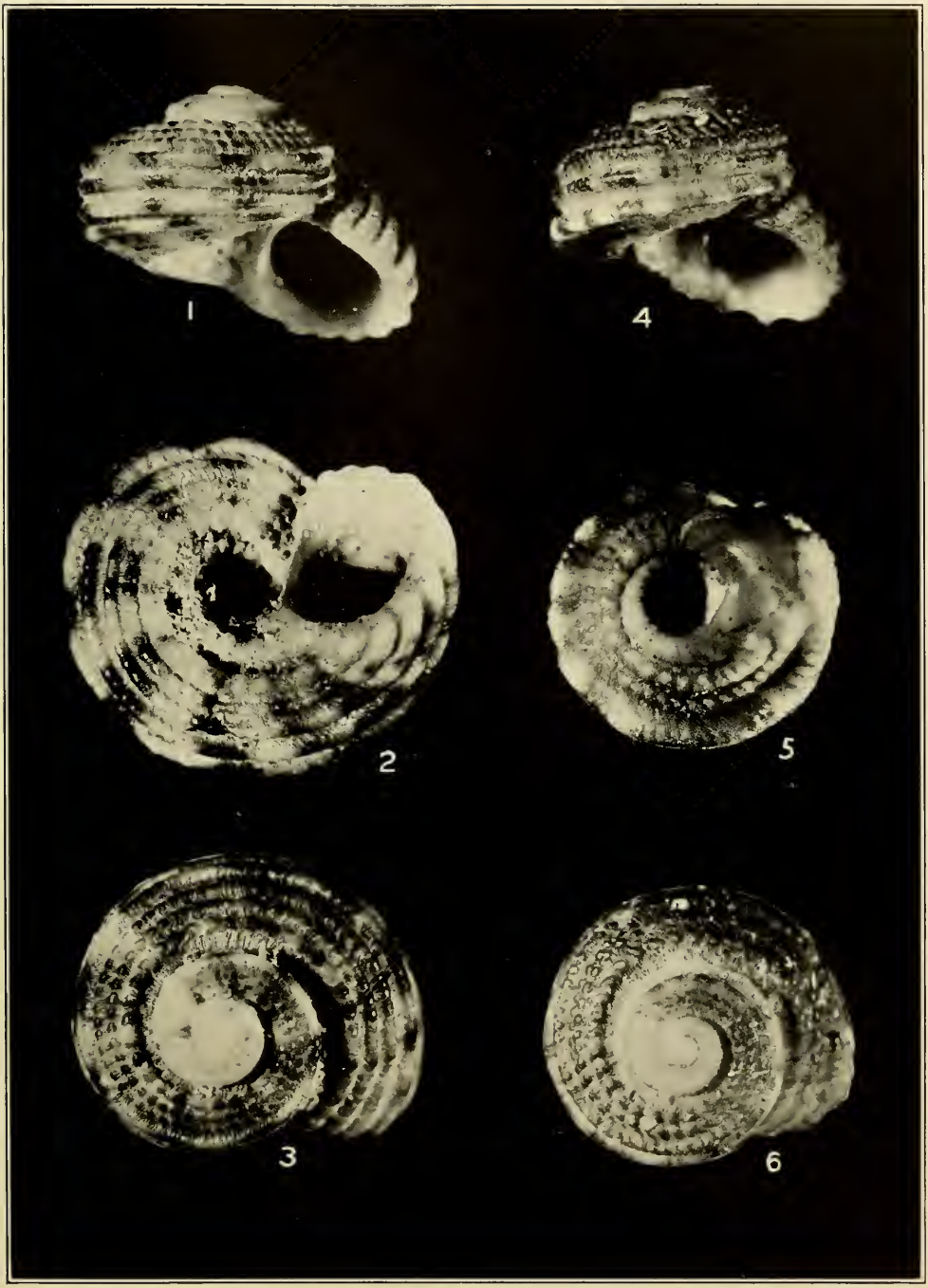
PLATE 31

Figs. 1, 2, 3. *Liotia carinata* Carpenter. Plesiotype, No. 5476, C. A. S.; Isla Raza, Gulf of California. Diameter, 5 mm.; altitude, 3.5 mm. [Page 440]

Figs. 4, 5, 6. *Liotia socorroensis* Strong, n. sp. Holotype, No. 5478, C. A. S.; Socorro Island, Mexico. Diameter, 6 mm.; altitude, 5 mm. [Page 439]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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VII, No. 38, pp. 453-454 MAY 31, 1934

SOME CORRECTIONS NEEDED IN RECENT CARCINOLOGICAL LITERATURE

BY

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In the course of studies I have undertaken on Pacific coast crustacea, it appears that a number of corrections in current American literature are in order and should be made. The more obvious of these that have come to my attention during the past several years are as follows. Errors can be expected during the progress of any science and my listing of some necessary corrections is done merely for the convenience of active workers in this field. Some of these corrections have been made, indirectly, by means of synonymic references in the works of Dr. Mary J. Rathbun, but others do not seem to have been noticed. The first column lists the items as published, the second lists the correct names. The author in each case is Lee Boone.

ZOOLOGICA, VOL. 8, 1927

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201	**Medaeus rugosus** sp. n.	**Lipaesthesius leeanus** Rathbun
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217	**Pilumnus spinulifer** Rathbun	**Medaeus spinulifer** (Rathbun)
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272	**Uca galapagensis** Rathbun, male	**Uca panamensis** (Stimpson)

Bull. Bingham Ocean. Coll., Vol. 1, 1927

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27	**Hexapanopeus hirsutus** sp. n.	**Panopeus harttii** Smith
45	**Lithadia geometries** sp. n.	**Ebalia cariosa** (Stimpson)
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57	**Munida elfina** sp. n.	**Munida sculpta** Benedict, young
91	**Nephrops binghami** sp. n.	**Nephrops rubellus** Moreira
121	**Glyphocrangon aculeata** A. M. Edw.	Near **Glyphocrangon spinicauda** A. M. Edw., but drawing not.

Bull. Amer. Mus. Nat. Hist., Vol. 58, 1929

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563	**Pitho quinquedentata** Bell	**Pitho picteti** (Saussure)
570	**Eurypanopeus purpureus** Lockington	**Menippe frontalis** A. M. Edw.
581	**Uca mordax** Smith	Fig. 17a. A reexamination of this material might prove this to be **Uca macrodactylus** (M. Edw. & Lucas)
581	**Uca mordax** Smith	Fig. 17b, c. **Uca panamensis** (Stimpson)

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53	**Persephona edwardsii** Bell	**Persephona subovata** Rathbun
54	**Persephona punctata** (Linn.)	**Persephona punctata punctata** Rathbun
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129	**Lophopanopeus heathii** Rathbun	**Eurypanopeus planissimus** (Stimpson)
158	**Portunus (Portunus) sulcatus** A. M. Edw.	**Cronius ruber** (Lamarck)
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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VII, No. 39, pp. 455-470, text fig. 1

A REVIEW OF THE RACES OF GEOCOCCYX VELOX

BY

ROBERT T. MOORE

California Institute of Technology

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

MAY 31, 1934

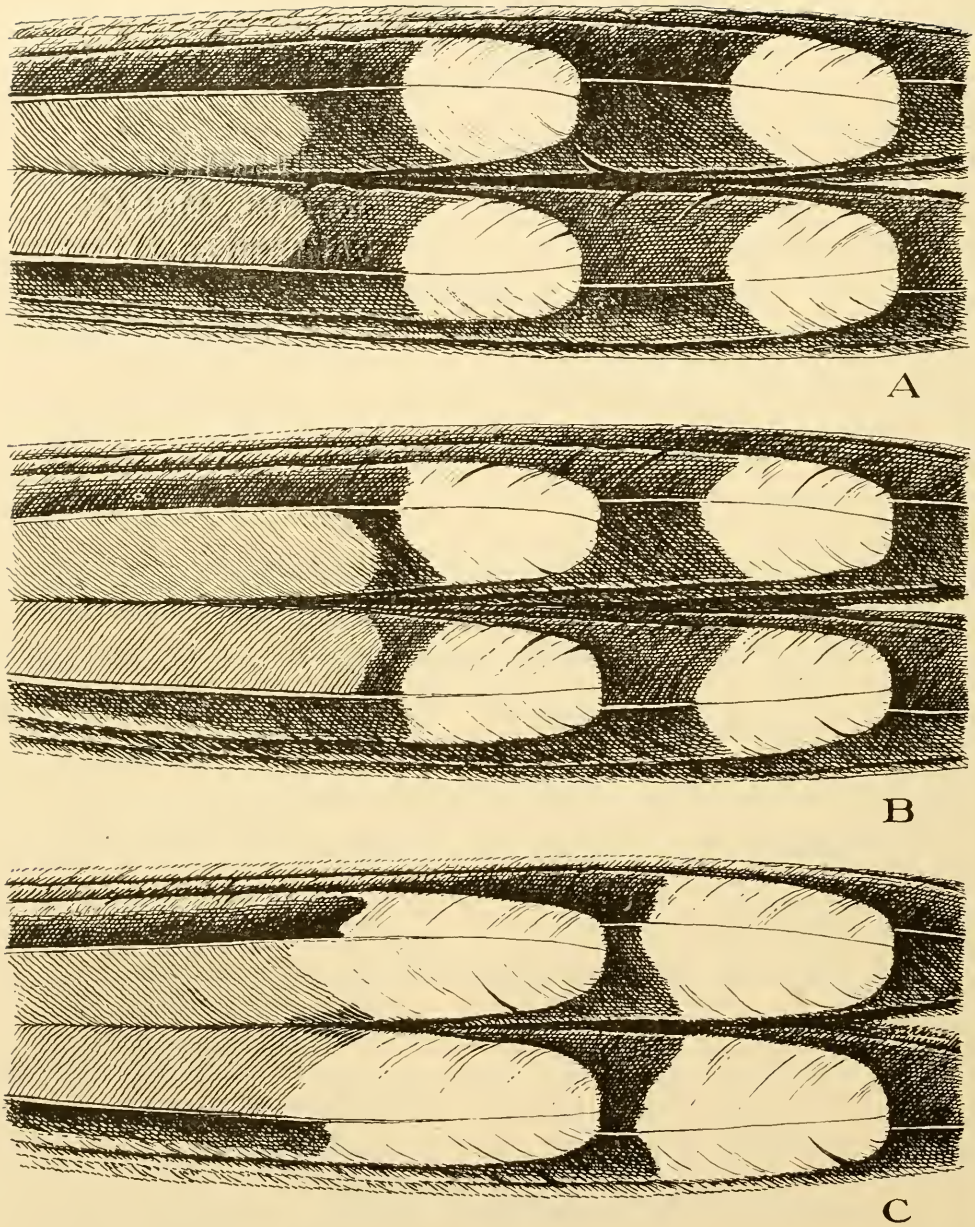

Fig. 1. Ink drawing by J. L. Ridgway of two outer pairs of rectrices of three races of *Geococcyx velox*. (A) *melanchima*, (B) *affinis* and (C) *longisignum*, all viewed from below.

A REVIEW OF THE RACES OF GEOCOCCYX VELOX

BY

ROBERT T. MOORE

California Institute of Technology

In preparation for the report on the birds of Sinaloa, one of whose chief objectives is the definition of the faunal areas of the state and their overflow into surrounding territory, I have described several races from extreme southern Sonora and northern Sinaloa. In continuation of this project, I shall publish others from time to time.

Ridgway, in The Birds of North & Middle America, recognized only two species of the genus *Geococcyx* Wagner—*Geococcyx californianus* (Lesson) and *Geococcyx affinis* Hartlaub. In his Addenda, part 7, p. 502, he accepted Hellmayr's dictum that the Lesser Roadrunner, named by Hartlaub *affinis,* had previously been described by A. Wagner as *Cuculus velox* in 1836, and changed the name of the smaller bird to *Geococcyx velox* (A. Wagner), reducing all previously described races to synonyms. I have assembled a large amount of new material which was not available to Ridgway, namely, an adequate series from Salvador collected by Adriaan van Rossem, a large series from Guatemala taken by A. W. Anthony, eight specimens from Honduras secured by C. F. Underwood and a considerable amount of new specimens from Nicaragua, Oaxaca, Tepic, Sinaloa and Sonora, totaling forty individuals which Ridgway did not have. Examining these, as well as those previously in the possession of the Museum of Comparative Zoölogy, the American Museum of Natural History and the Smithsonian Institution, it is now possible to recognize not only certain stable differences of coloration, but also important characters, apparently not hitherto mentioned in the literature of the subject, which prove uniform in their modifications from one faunal area to another. These latter are chiefly the relative proportions of black, white and gray on the two outer rectrices and the presence or absence of the subterminal black bar on the outer one, which separates the light gray of the basal area of the inner webs from the white tips. In the males of northwestern Mexico this bar averages approximately 20 mm. wide, in Guatemalan and Salvadoran birds 10 mm. wide, whereas

in birds from Honduras and Nicaragua it disappears entirely, or is negligible.

The type of *Cuculus velox* was described in some detail by Hellmayr in Novitates Zoologicae, Vol. XX, 1913, p. 253, and recently has been examined by van Rossem. Their reports prove that it is a very dark form similar to the four birds I have examined from Vera Cruz and it undoubtedly came from Mexico City. We, therefore, have four recognizable forms of *velox*:

1. A dark cinnamon-buff bird in east-central Mexico with concolor back and rump, short tips to rectrices and a very wide subterminal black bar on the outer one, to which the name *velox* applies;

2. A pale bird in northwestern Mexico with two-tone back and rump, equally short tips and narrow black bar;

3. In Guatemala and Salvador a buff and rusty bird with much narrower black bar on outer rectrix, much longer white tips to all rectrices and gray appearing on inner web of second rectrix. For this the name *affinis* of Hartlaub applies, since Hartlaub's type undoubtedly came from Guatemala;

4. In Honduras and Nicaragua a form with tendency toward white and black, separated from all other races by disappearance of the black bar on lateral rectrices, much longer tips to all three outer rectrices, and very dark brown upper parts with concealed marks of green. I, therefore, recognize *velox* of eastern Mexico, *affinis* as a race in Guatemala and Salvador, and describe the bird of northwestern Mexico and the Honduras-Nicaraguan form.

Geococcyx velox

Specific characters.—Similar to *Geococcyx californianus* (Lesson), but size smaller; pileum black; upper parts browner, Tawny[1] through Cinnamon Buff to dark greenish brown; foreneck and chest unstreaked medially; under parts of body Light Buff to Cinnamon Buff; under tail-coverts Dusky Drab to Blackish Brown, tipped with Cinnamon Buff. Male, wing 132-154 mm.; tail 250-303 mm.; exposed culmen 32.5-41.9 mm. Female, similar to male, but very slightly smaller. Wing 126.5-149.7 mm.; tail 245-277 mm.; exposed culmen 32.1-40 mm.

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[1] Capitalized names of colors in paper taken from Ridgway, Color Standards and Color Nomenclature, 1912.

Geococcyx velox melanchima[2] subsp. nov.

PALE ROADRUNNER

Type.—Male adult; no. 4239, collection of Robert T. Moore; Guirocoba, Sonora, Mexico, (altitude 2500 ft.); March 25, 1931; collected by J. T. Wright.

Subspecific characters.—Nearest to *Geococcyx velox velox* (A. Wagner), but buff of under parts much lighter; throat almost white instead of Light Buff to Warm Buff; abdomen whitish and not concolor with rest of underparts; apical spots on feathers of crown and hind-neck whiter; back lighter, Rood's Brown instead of Carob Brown; feathers of rump darker with tips Tawny Olive instead of Russet; and streaks of upper parts lighter.

Description of Type.—Adult male, no. 4239. Feathers of pileum black, each with two subterminal, lateral spots, white to very light buff, the spots more numerous and more truncated on forehead and anterior part of crown; hind-neck and upper back black margined by whitish with subterminal margin of Ochraceous-Tawny; back and scapulars Cinnamon-Brown, the feathers margined with white, creating conspicuous streaks; wing-coverts with broad median streak of black, broadly edged with white, faintly tinged with very pale buff, the greater coverts Vinaceous-Purple medially with bronzy green sheen, broadly edged with whitish or very pale buff; proximal secondaries (tertials) Carob Brown with Dark Vinaceous-Purple sheen, edged with whitish; primary coverts black with faint greenish sheen basally, terminal half white; primaries Clove Brown with wide medial longitudinal blotch on inner web Pallid Brownish Drab, margined by darker, the distal third of outer webs obliquely crossed near middle portion by a broad band of white, the outer webs broadly tipped with white; feathers of rump Clove Brown subterminally grayish at base and tipped with Tawny Olive; upper tail-coverts Buffy Brown to Olive-Brown margined by white; median rectrices Dusky Drab with faint gloss of Vinaceous-Drab, Chaetura Black subterminally, the entire feather edged narrowly on both margins and tipped with white; next pair glossy American Green mottled with glossy Dark Vinaceous-Brown, each feather margined even more narrowly on the sides than the median pair with white, but with larger white tip; outer webs of remaining rectrices from Dusky Dull Green on outer to Olivaceous Black on third, with faint gloss, margined by white, the inner webs lighter green, more largely tipped with white, the white tip increasing in width to outermost pair, the tips of three outer pairs (beginning with the lateral rectrices) measuring 27.8 mm., 26.2 mm. and 9.1 mm.; under surface of median rectrices Glossy Fuscous, next pair Glossy Fuscous-Black, three lateral rectrices Chaetura Black; the basal three-quarters of inner webs of lateral rectrices above light gray, this separated from white tip by a band of black, 24.7 mm. in length[3]; right hand feather of second pair of rectrices from outside with very small median area of light gray, left hand without any; lores

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2 Taken from the Greek noun μελάγχιμα, meaning "dark spots in snow," referring to the appearance of the subterminal black bar, set between the pure white tip and the grayish white web of the outer rectrix.

3 The length of this bar throughout the paper means distance along the shaft and not across the feather, and will hereafter be called "length" and not "width."

white; auricular region streaked with black and whitish; chin, throat and center of abdomen white with only a faint cast of very Light Buff, rest of underparts Light Buff to Warm Buff, darker on chest and thighs; sides of neck and sides of chest white to Light Buff, broadly streaked with black; maxilla dark grayish black above to light gray along the tomium; mandible Pale Dull Gray; unfeathered soft parts about the eye and of the bare orbital space Light to Deep Soft Blue-Violet without any red or orange; iris light hazel; legs Puritan Gray; toes Celandine Green[4].

Measurements.—Average of 14 adult males, wing 139.6 mm.; tail 269.6 mm.; exposed culmen 38.5 mm.; outer anterior toe minus claw 29.8 mm.[5]; tarsus 49.5 mm. Average of 13 adult females, wing 134.6 mm.; tail 260.8 mm.; exposed culmen 36.3 mm.; outer anterior toe minus claw 29.2 mm.[6]; tarsus 47.7.[7]

Specimens examined.—Twenty-five specimens: Sonora, 1 ♂ and 1 ♀; Sinaloa, 4 ♂ and 3 ♀; Tepic, 1 ♀; Jalisco, 3 ♂ and 1 ♀; Colima, 1 ♂ and 1 ♀; Guerrero, 1 ♂ and 2 ♀; Oaxaca, 4 ♂ and 2 ♀.

Range.—Arid Tropical Zone from southern Sonora to Colima and probably to Oaxaca.

Remarks.—This form differs from *affinis* in having the white tips to three outer pairs of rectrices much shorter (see Table of Measurements); subterminal black bar of outer rectrix much longer; no gray on second rectrix of specimens examined; upper back averaging lighter in series; their bases as well as those of scapulars less green. The relationship with the Honduran form will be discussed under that race.

Smallest of all the races, with the exception of the birds of Yucutan, *melanchima* frequents the cactus and mesquite association, following it from sea level into the oaks, wherever open conditions may be found, to approximately 3000 feet. Whether its pallid body tones may be correlated with hot desert conditions, it seems likely that the excess proportion of black in its rectrices finds its source in deeper biological processes. As a species it is not confined to desert conditions, but is found in open spaces among the pines at higher altitudes. It reaches 4500 feet in La Balla Mountains of southern Sinaloa and 8000 feet in the Wakenakili Mountains of Jalisco. All specimens examined from these higher elevations show darker coloration above and below and larger size, approaching *velox*, whose type came from an elevation of 7500 to 8000 feet. There is some individual variation, but these birds I classify as incipient intergrades, but nearer *melanchima*. They retain the long black bar on second rectrix and the short white tip characteristic of both *melanchima* and *velox*. It is highly probable that a good series from eastern Jalisco, Michoacan, and Puebla will produce more definite intergrades with *velox*.

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[4] These colors are taken from a painting made in the field by Mrs. J. T. Wright.

[5] Nine specimens. Measured from anterior margin of last undivided scute.

[6] Five specimens.

[7] Seven specimens. For measurements of markings on rectrices for all races see table at end of paper.

Geococcyx velox velox (A. Wagner)

LESSER ROADRUNNER

Cuculus velox A. WAGNER, Münchener Gelehrte Anzeigen, iii, p. 95, (July 1836.—Mexico; Karwinski Coll.).

Type.—In the Zoological Museum, Munich: ad., Mexico—Karwinski Coll. Type of *Cuculus velox* A. Wagner.

Measurements of Type.—"Wing, 138; Tail, 275; Culmen (tip broken); Tarsus, 50; Middle Toe minus Claw, 29; Collector Karwinski; no sex; Mexico. No number."[8]

According to Dr. Hellmayr[9], "*Cuculus velox* was described by Dr. Andreas Wagner, then Curator of the Zoological Collections at Munich, from an example obtained by Karwinski somewhere near the City of Mexico (exact locality not stated)." He adds, "The underparts are uniform buff, paling into whitish on chin and upper throat; - - - the sides of foreneck and chest only are marked with broad, black shaft-stripes. Above, the crown and nape are black - - the back - - is bright rufescent-brown." Mr. van Rossem has kindly loaned his note regarding his examination. Confirming Hellmayr's description of the type, he calls it a "very dark colored bird" with "streaks on the chest and neck—black and broad". He gives in addition the measurements of the white tips of the three outer rectrices, beginning with the lateral first as "30, 15 and 6 mm. respectively - - - third (6 mm. tips) pair are new." These combined descriptions fit perfectly the Vera Cruz birds I have examined. They are "very dark colored" birds. Furthermore, the small measurements of the white tips to the three outer pairs of rectrices, taken in conjunction with the descriptions, furnish convincing evidence that the Type came from either the state of Vera Cruz or near Mexico City. Of the sixty-six specimens of *velox*, none except the birds of east Mexico and *melanchima* of northwestern Mexico have tips as small as these. However, the dark coloration of the type distinguishes it sharply from the latter. That this "dark" cinnamon coloration is not due to "foxing" is proved by 18 specimens of *melanchima* and *affinis*, collected by Sumichrast 1868, Llarregin 1864, Schott 1864, Gaumer 1880, Brown 1889, Batty 1904, Xantus and Grayson, which have retained the lighter coloration of these two races. Finally, the ordinary measurements of the Type, covering wing, tail, and culmen are almost identical with the average of the Vera Cruz specimens. I, therefore, believe it reasonable to accept Hellmayr's statement that the type was obtained "somewhere near the City of Mexico" and I herewith suggest the outskirts of Mexico City as the type locality.

Subspecific characters.—Differs markedly from all its races in much darker cinnamon underparts, practically concolor throughout (except for the under tail-coverts) with throat only a trifle lighter; much darker back, Carob to Liver

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[8] Data concerning Type taken from van Rossem's notes, made in Munich, Aug. 19, 1933. Van Rossem's measurements of wing and tail are slightly less than those given by Hellmayr, Novit. Zool., Vol. xx, 1913, p. 253, but Hellmayr probably measured wing and tail in a different way. As van Rossem's method is similar to my own, I am using his figures as giving a better comparison.

[9] 1913, Hellmayr, Novit. Zool., xx, p. 253.

Brown, with a distinct cinnamon cast; rump practically concolor with back, which is differently colored in the other three races; streaks on upper parts, sides of neck and upper chest darker—Warm Buff to Cinnamon or Rusty. In addition, it differs from all but *melanchima* in short tips to all three pairs of outer rectrices and a long subterminal black bar on the lateral.

Measurements.—4 adults, excluding Type, wing 139.8 mm.; tail 273 mm.[10]; exposed culmen 37 mm.[11]; tarsus 50.7 mm.[11]; outer anterior toe minus claw 29.6 mm.[12]

Specimens examined.—Five specimens: 1 (the Type) by Adriaan van Rossem, 4 from Vera Cruz by myself.

Range.—Mexico to Vera Cruz. The exact limits of the range of this form cannot be determined until more material is collected from points further south and west.

Remarks.—Whether true *velox* intergrades with *melanchima* or with *affinis* it will be impossible to decide until adequate specimens are secured from eastern Jalisco, Michoacan, Morelos, southern Puebla and southern Vera Cruz.

Geococcyx velox affinis (Hartlaub)

RUSTY ROADRUNNER

Geococcyx affinis HARTLAUB, Rev. Zool., vii, June, 1844, 215 (Guatemala; coll. Bremen Mus.?).

Subspecific characters.—Nearest to *velox velox* in coloration, but under parts generally paler—less cinnamon; throat always whiter; light streaks of upper parts and spots on crown generally whiter; tips of rectrices longer; and subterminal black bar on outer rectrix shorter.

Differs from *melanchima*, in having tips to all three pairs of outer rectrices decidedly longer; subterminal black bar of outer rectrix much shorter—50 per cent; a gray area, similar to that of the outer rectrix, appearing in large blotches on second pair of rectrices; upper back averaging darker in series with bases of feathers, as well as the scapulars, marked with dark green. The relationship of *affinis* to the Honduran form will be discussed under that race.

Measurements.—Eight males from Guatemala, wing 142.8 mm.; tail 276.9 mm.; exposed culmen 37.1 mm.; outer anterior toe minus claw 28.3 mm. Eight females from Guatemala, wing 145.1 mm.; tail 273.2 mm.[13]; exposed culmen 34.9 mm.; outer anterior toe minus claw 28.6 mm. Three males from Salvador, wing 146.4 mm.; tail 267.3 mm.; exposed culmen 38.6 mm.; outer anterior toe minus claw 29.3 mm. Seven females from Salvador, wing 138.2 mm.; tail 266.7 mm.; exposed culmen 36.2 mm.; outer anterior toe minus claw 29.5 mm. Ten adults from Yucutan, chiefly without sex determination, wing 132.4

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[10] Three specimens.

[11] Three specimens.

[12] For measurements of black and white areas on rectrices, see table at end.

[13] Four specimens.

mm.; tail 242.2 mm.; exposed culmen 39.4 mm.; outer anterior toe minus claw 28.2 mm.[14]

Specimens examined.—Thirty-seven specimens: Guatemala: San Lucas, 1 ♂ and 1 ♀; Sacapulas, 1 ♂; Progresso, 1 ♂ and 1 ♀; Panajachel, 1 ♂ and 2 ♀; Coban, 1 ♂; Finca la Primavera, 1 ♀; Finca Concepcion, 1 ♀; San Antonio, 1 ♀; Guatemala City, 1 spec.; "Guatemala", 3 ♂ and 1 ♀. Salvador: Los Essimeles, 1 ♂ and 2 ♀; near Lake Olomega, 1 ♂ and 2 ♀; Colimes de Tucuaran, 1 ♂; Vol. San Miguel, 1 ♀; Pinne Pealis, 2 ♀. Yucutan: Merida, 2 ♂; Xbac, 1 ♂; Temax, 2; Peto, 2; Izalam, 1; Progresso, 1; "Yucutan," 1 spec.

Range.—Chiefly the Subtropical Zone of Guatemala and Salvador in arid regions, and the upper levels of Tropical Zone. It "never reaches sea-level" in Nicaragua.[15]

Remarks.—*Geococcyx affinis* was described by Hartlaub, according to Ridgway, from a specimen secured in Guatemala. No hint is given as to its source, but the specimen is presumably in the Bremen Museum. As the description was published in 1844, it seems a reasonable presumption that the specimen came either from one of the collections of Señor Don José Vicente Constancia or was taken by Delattre, since our records do not reveal any other large collections made prior to 1844. Constancia's headquarters were at Antigua. Most of his birds were probably obtained from an elevation of 5000 to 8000 feet. Delattre maintained headquarters at Coban, whose elevation is "variously given from 3800 to 4356 feet"[16]. In either case it is not likely that the Type was secured at an elevation lower than 3000 feet. Of the thirteen collecting stations, cited by Griscom for Guatemala, only two are below 3200 feet and of the seventeen specimens, which I have examined, only two came from an altitude lower than 3200 feet and no bird at all lower than 2000 feet. Practically the same is true of the birds in the Dickey Collection from Salvador; only three of the ten came from below 3000 and none below 1200 feet. On the other hand it ranges as high as 6700 feet in Guatemala and 6400 feet in Salvador. It would seem obvious that *affinis* is largely a Subtropical Zone bird. Salvador specimens average slightly darker on the upper back with the green more pronounced on the bases of the feathers, but are essentially *affinis*.

The birds from Yucutan are somewhat difficult to determine because of inadequate data, as well as the practical absence of material from intermediate areas. They have unusually short tails, tips and black bars close to *affinis*, and considerable individual variability in coloration. Some are quite pale like *melanchima* which would be anticipated in an Arid Tropical Zone bird. They do not have *melanchima's* long black bar on outer rectrix, nor short tips. It is possible they are subspecifically distinct. Until fresh material is collected in Yucutan, it seems best to record them tentatively as *affinis*.

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[14] Four specimens. For measurements of black and white areas on rectrices, see table at end.

[15] 1932, Griscom, Bird Life in Guatemala, p. 50.

[16] 1932, Griscom, Bird Life in Guatemala, p. 416.

We should expect intergrades between *affinis* and *melanchima* in Chiapas, but there are no available specimens. Individuals from southwestern Oaxaca near the coast are *melanchima*. Similarly no specimens are available from the large area between the Motagua River of central Guatemala and Teguagalpa in southern Honduras. We should expect intergrades between *affinis* and the Honduran race along the Merendon Mountain Range.

Affinis is a weaker race than any of the others, and, except for tail characters, closer to true *velox*. It is obviously not an intergrade between *melanchima* of the northwest and the Honduran form, since in coloration it is darker buff below than either of them, having its affinities with *velox*. Until the type has been examined critically and more specimens of the latter with full data secured, it seems well to recognize this race.

Geococcyx velox longisignum[17] subsp. nov.

BLACK AND WHITE ROADRUNNER

Type.—Male adult; no. 161178, collection of Museum of Comparative Zoölogy; Comayabuela, Honduras; Oct. 1, 1931; collected by C. F. Underwood.

Subspecific characters.—Nearest to *Geococcyx velox affinis* (Hartlaub), but white tips to the three outer rectrices much longer, tips to lateral rectrices merging with light gray area on inner webs and eliminating the black subterminal bar, the gray area slightly longer; gray area on second rectrix much longer and always present; the back darker brown in series; feathers of nape and upper back nearly black, more prominently marked with green at base of feathers, largely concealed; lighter streaks on sides of neck and upper chest whiter (in most specimens pure white); lighter streaks on scapulars, back, nape and spots on crown whiter (generally pure white).

Description of Type.—Adult male in newly moulted plumage nearly completed. Identical with description of Type of *melanchima*, except for the following: Spots of pileum white; hindneck black, the feathers broadly edged with white; upper back and scapulars Mummy to Prout's Brown, the feathers darker basally and marked with green, largely concealed, the margins sharply edged with white or buffy white; wing-coverts broadly edged with pure white, the greater coverts black very broadly tipped with white; proximal secondaries (tertials) brown; other secondaries dull blackish glossed with bronze-greenish, edged (except towards base) with white, the outer web with a terminal spot of the same; alulae dull black medially, broadly margined with white; primary coverts dull black basally; primaries dull black; lower back Clove Brown, each feather with a streak along shaft of Deep Olive, tipped with Cinnamon-Brown; feathers of rump tipped with Ochraceous-Tawny; outer webs of upper tail-coverts deep Brownish Vinaceous, slightly iridescent and glossed with greenish when seen at certain angles, inner webs more greenish and more narrowly edged with white; median rectrices Deep Livid Brown glossed with Purplish Vinaceous and along the shaft with greenish, this shaft-mark broadening toward the tip into

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[17] Latin *longus*=long, and *signum*=a mark or banner, referring to the long white tips of the outer rectrices.

glossy Dusky Olive Green; next pair not fully developed, glossy Dusky Olive Green and with a white terminal spot about 10 mm. long; next pair of the same color; the next pair a slightly darker glossy green; lateral rectrices dusky Slate Olive on the inner web, Olivaceous Black along the shaft of outer web, bordered broadly by white on outer web, more narrowly on the inner, without any subterminal black bar; the tips of three outer pairs (beginning with lateral rectrices) measuring 49 mm.; 42 mm.; and 21.4 mm.; under parts Light Buff, touched here and there with Warm Buff, paler on abdomen, almost pure white on chin and throat; sides of neck and sides of chest broadly streaked with black, the black streaks broadly margined with an equally wide streak of pure white; under tail-coverts dusky tipped with Russet; maxilla dull horn color, mandible mostly dull yellowish or grayish in dried skin.

Remarks.—This southern race is the extreme form of the elimination of the rusty tones and the tendency to replace them with dark brown, black and white. It differs markedly in coloration from true *velox*, being largely black and white where *velox* is cinnamon and buff. It resembles *melanchima* in the tendency toward white spots on the crown and white on the throat and streaks of the sides of the neck, but it differs from both of these northern forms in all of the characters mentioned under "*subspecific characters*" above. Both *velox* and *melanchima* have long subterminal black bars on the outer rectrices, whereas *longisignum* has none. Most of the specimens I examined from Honduras and Nicaragua come from altitudes between 3000 and 3200 feet and the altitude of the remainder I have not determined. Apparently it does not reach sea level.

Measurements.—Seven males from Honduras, wing 143 mm.; tail 278 mm.; exposed culmen 39.6 mm.; outer anterior toe minus claw 29.2 mm. Six males from Nicaragua, wing 145.3 mm.; tail 279.7 mm.; exposed culmen 38.7 mm.; outer anterior toe minus claw 31.3 mm. Three females from Nicaragua, wing 140.1 mm.; tail 268.8 mm.[18]; exposed culmen 36.6 mm.; outer anterior toe minus claw 30.6 mm.[19]

Specimens examined.—Seventeen specimens: Honduras: Comayabuela, 4 ♂ and 1 spec. without sex indication; Mount Redondo, 3 ♂. Nicaragua: Ocotal, 2 ♂; Matagalpa, 2 ♂ and 2 ♀; near Matagalpa, 1 ♂; San Rafael del Norte, 1 ♂ and 1 ♀.

Range.—Honduras and Nicaragua.

General remarks.—The races of *velox* as a whole are subject to considerable individual variation in certain items of body coloration—width of stripes on sides of neck and amount of spotting on crowns—but the changes in amounts of black and white on the rectrices show surprisingly little variability and serve as excellent characters. In general, northern birds, both true *velox* and *melanchima*, have small white tips, short gray areas and very large black subterminal bars on outer rectrices, whereas

[18] One specimen.

[19] For measurements of black and white areas on rectrices, see table at end.

southern races have the white and gray areas greatly increased in size, the black subterminal bar on the outer rectrix reduced fifty per cent in *affinis* and disappearing in *longisignum*. In *longisignum* we have a great enlargement of the gray area on inner webs of second pair of rectrices from the outside (see measurements in table). This appears in every one of my fifteen specimens from Honduras and Nicaragua[20], and is very conspicuous in eleven of them. On the other hand, it is entirely absent in seven specimens of *affinis,* prominent in six and vestigial in three. Unfortunately, I did not notice this character, when I was examining the specimens in eastern museums of *velox* and *melanchima,* but of the four specimens that are before me, one of *velox* and two of *melanchima* do not possess it and a third one of the latter has only a very small streak on one feather. I think further examination will prove it practically absent from northern races.

Of the fifteen specimens examined of *longisignum,* the subterminal black bar of outer rectrix is absent or vestigial in all except one—no. 161176, Museum of Comparative Zoölogy, from Monte Redondo, Honduras. By contrast, not one of the sixteen specimens of *affinis* from Guatemala, which I have examined for this character, are without the black bar and only one of ten specimens of *affinis* from Salvador lacks it.

Griscom has shown[21] that the Lesser Roadrunner of Guatemala is one of several typical species of the desert interior valleys that "could only have emigrated from farther north or have descended from the lower levels of what is now the Arid Temperate Zone." He has also shown that the arrival of the Glacial Epoch was a factor of extreme importance in Guatemalan bird life and that the increased refrigeration drove the birds from the then Subtropical Zone down to sea level and that subsequently the close of the Ice Age reversed the movement and the Subtropical Zone was gradually recaptured by such individuals as had survived at the lower levels. It is probable that *Geococcyx velox,* was such a species, and that the upward movement from sea level conditions has not yet ceased. Whether it ever reached the coast in Nicaragua, Honduras, Guatemala and Salvador or was stopped by humid coastal tree-growth, it is no longer at sea level today and could not endure the heavy growth which seems to cover the coasts of these countries. Van Rossem assures me such is the

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20 In American Museum specimen no. 102775, one outer rectrix appears not to have this gray area. This is an illusion, as the feather has been completely twisted around, the real under side of the feather now being on top.

21 1932, Griscom, Bird Life in Guatemala, p. 50.

condition in Salvador, but that the bird is found in stony grasslands twenty-five miles from the sea at an altitude of 1200 feet. It is now found at sea level only in the northwest, and in the peculiar isolated Arid Fauna of Yucutan. It also comes close to the coast in extreme southwestern Oaxaca and probably at other points between Oaxaca and Sinaloa. It does not seem to be a common bird anywhere at sea level. Dr. Gaumer stated it is rather rare in northern Yucutan, except at Rio Lagartos, and Stone met with it only near Tekanto. Although specimens have been collected in Mazatlan, Sinaloa, the experience of two veteran collectors during the past year, J. T. Wright and C. C. Lamb, proves that it is not by any means common. Therefore, it seems reasonable to say that this species was formerly a Subtropical or Arid Temperate bird, that its excursion to sea level was a forced one, that its new environment has not been altogether agreeable; that at least one race which still remains there in diminished numbers, *melanchima,* has acquired a pallid coloration. This last cannot be said of lower level birds of Central America, which, perhaps because of additional climatic factors, are not uniform in this respect.

Average Measurements of Tail Characters in *Geococcyx velox*

Males	*Length Tip Lat. Rec.*[1]	*Length Black Bar Lat. Rec.*[2]	*Length Gray Lat. Rec.*[1]	*Length Tip 2nd Rec. from Outside*[1]	*Length Gray 2nd Rec.*[1]	*Length Tip 3rd Rec.*[1]
4 from Vera Cruz (*velox velox*)	35.6	18.3	103.6[3]	27.7	0.0[3]	14.3[5]
8 from Son., Sin., Col., Jal., and Oaxaca (*melanchima*)	34.7	20.7	112.1[3]	27.9	17.2[4]	15.4
10 from Guatemala & Salvador (*affinis*)	37.1[7]	9.9[8]	114.3[6]	32.2[8]	37.9[6]	18.1
4 from Yucutan (no sex) (prob. *affinis*)	38.4	6.6		32.4		17.3
13 from Honduras & Nicaragua (*longisignum*)	42.9	1.6	117.2[7]	37.8[10]	75.6	23.2[9]
Females						
6 from Sin., Tepic & Oaxaca (*melanchima*)	33.6	18.6	110.9[5]	28.2	0.0[5]	15.2
15 from Guatemala & Salvador (*affinis*)	35.1	11.7	115.4[11]	31.8	46.3[12]	18.0[12]
3 from Nicaragua (*longisignum*)	37.4	4.9	122.3[3]	31.6	37.1[3]	17.2

[1]—Greatest length parallel with shaft.
[2]—Length along shaft.
[3]—One specimen.
[4]—One specimen—Average of 2 lateral rectrices. A very narrow broken streak on only 1 rectrix.
[5]—Two specimens.
[6]—Three specimens.
[7]—Eight specimens.
[8]—Nine specimens.
[9]—Ten specimens.
[10]—Eleven specimens.
[11]—Twelve specimens.
[12]—Thirteen specimens.

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